SCIENTIFIC AMERICAN SUPPLEMENT

Scientific American Supplement, Vol. I., No. 22.
Scientific American, established 1845.
New Series, Vol. XXXIV., No. 22.

NEW-YORK, MAY 27, 1876.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.
Postage free to Subscribers.

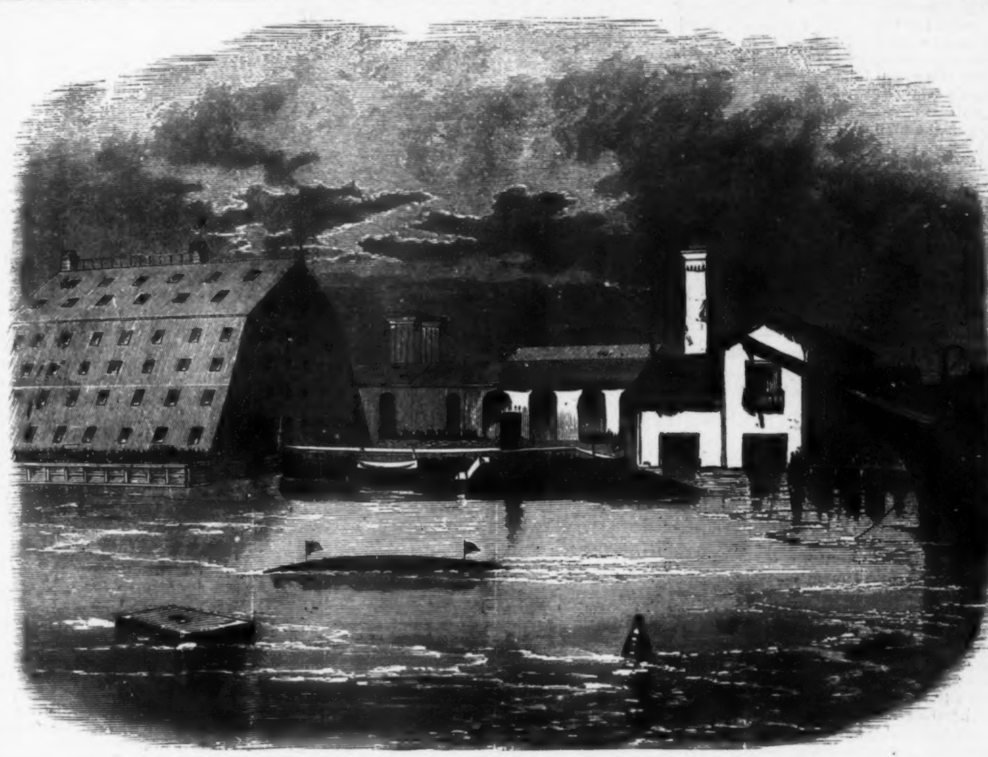
RECENT TRIAL OF THE LAY TORPEDO.

An exhibition of unusual interest and importance to modern warfare took place at the Navy-Yard in Washington, being a practical trial of the Lay Torpedo, made under direction of the Navy Department.

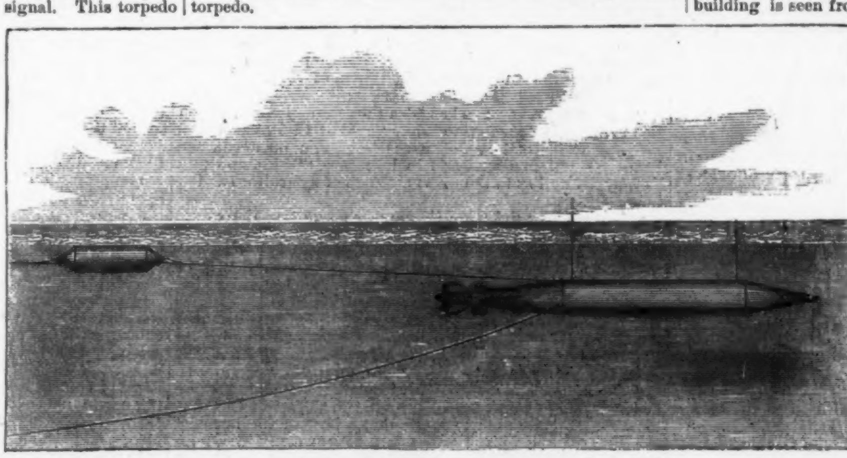
The Lay Torpedo is a cylindrical iron hull, of cigar shape, twenty-three feet in length, twenty-two inches in diameter, propelled by a carbonic-acid engine, and capable of carrying a magazine with an explosive force equal to a ton of gunpowder. The vessel is run submerged in the water, without any person with it or attending it, and is wholly guided and perfectly controlled in all its movements by the operator, who is stationed on shore, or on shipboard, who directs all the motions of the boat, and explodes the magazine at will by the agency of a single small electric cable attached to the boat, and which pays out as she runs, the other end being attached to a small keyboard which is under the hand of the operator. At this trial the boat was manipulated by Captain Bradford, of the Navy, and demonstrates that the torpedo is easily manageable in action; that she can be sent with accuracy and speed in any required direction. The water at the Navy-Yard is very shallow, and the channel crooked, but the runs made, in all a mile and six-tenths, were without any failure or accident, and the torpedo was exploded instantly on the electric signal. This torpedo cannot explode by concussion, and can only be exploded at the will of the operator, thus securing both safety and certainty in its operation. It was the opinion of those who witnessed the experiment that the Lay Torpedo is the most formidable and effective weapon of warfare ever invented and constructed. Not only for attacking and destroying an enemy's vessel, but for coast and harbor defence, it appears to be in all respects perfectly adapted to the purpose.

Mr. Lay's invention is calculated to revolutionize the entire system of naval warfare, particularly that branch pertaining to harbor defence and protection of fortifications, as well as open combat between floating navies. So fast as shipbuilders have been able to construct the thickest metallic defences for naval vessels, so fast have manufacturers of guns been able to invent projectile that will pierce them. The submerged torpedo is impregnable to attack. With its explosion it carries far wider destruction than the most terrific storm of shot and shell, and the loss of life inevitable upon a close naval conflict is entirely avoided. The advantages of the movable torpedo over the fixed mines and the spar torpedo are so apparent that it is not necessary to enumerate them. The torpedo-boat is calculated to be used in a most efficient manner for offensive warfare. It can be used as a towing-boat to effect an entrance to the harbor of an enemy or approach his fortifications, even if they are protected with fixed mines or torpedoes in the channel. To the Lay torpedo-boat may be attached a line of floating explosive mines, connected with the operator's station as the torpedo itself, with electric cable. The torpedo-boat may be dispatched with these floating mines in tow to open the channel. The mines can be detached from the boat at any given point and sunk in position by an arrangement peculiar to their construction, still retaining their electrical cable connection with the operator's station. They may be fixed at will. Mr. Lay has invented a submarine torpedo-battery for harbor and coast defence. It is similar to the ship-floating torpedo.

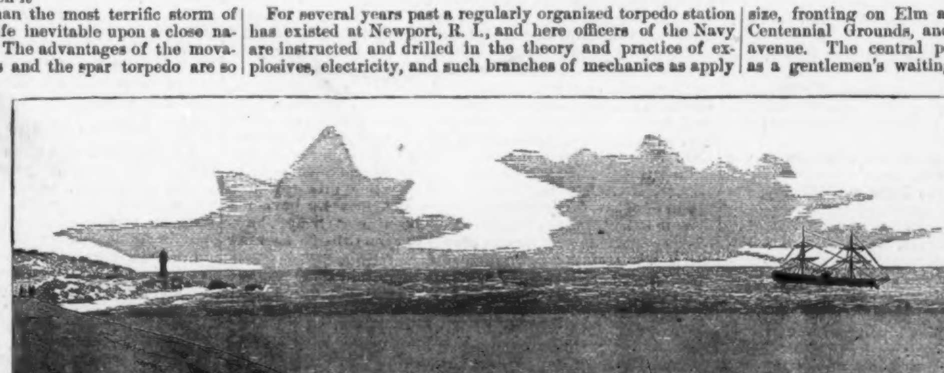
For several years past a regularly organized torpedo station has existed at Newport, R. I., and here officers of the Navy are instructed and drilled in the theory and practice of explosives, electricity, and such branches of mechanics as apply thereto. A new and fast steam torpedo-boat for towing torpedoes has lately arrived at this station. This boat, it is said, will steam at the rate of nineteen miles an hour. We shall describe her hereafter.



EXPERIMENTAL TRIALS OF THE LAY TORPEDO, NAVY-YARD, WASHINGTON, D. C.



THE LAY TORPEDO TOWING OTHER TORPEDOES.



THE LAY TORPEDO MOVING TOWARDS AN APPROACHING VESSEL.

THE PENNSYLVANIA RAILWAY PASSENGER STATION AT THE EXHIBITION ENTRANCE.

A large measure of the success that will attach to the Centennial will be owing to the liberality and enterprise of the Pennsylvania Railroad Company. That it has extensively displayed both is shown by the great improvements made at its own expense in the vicinity of the Exhibition grounds—improvements that were not forced by competition, because its road is the only one running to the grounds. They were provided, therefore, without expectation of money-making, and solely for the accommodation of visitors. Next to the Main Building and Machinery Hall, the first structure to attract the attention of the visitor approaching the grounds on their southern side is the company's new Centennial Depot, just completed. It looks more like a gigantic and very attractive birdcage than a depot, and possesses many of the characteristics of the Main Exhibition Building, being constructed, like it, of wood, iron, and glass. In our illustration (p. 345), which is from *Frank Leslie's Illustrated Newspaper*, the building is seen from a point on Belmont avenue, a few hundred feet south of the Centennial grounds. In the foreground on the left, and immediately back of the depot, is seen the top of Machinery Hall; the smaller building between the latter and the depot is the Shoe and Leather Building; further to the right and rear are the Board of Finance and the Commission Pavilions. The Main Building is seen in the picture on the other side of Belmont avenue, and Judges' Hall is still further in the rear on the right. Half a mile distant, on the summit of Belmont, is easily seen the Observatory, 150 feet high, with a covered platform on the top, capable of accommodating 150 persons at one time. The car, shaped like a cylindrical ring, runs up and down the exterior. Further to the left, and in the background, is the high ground known as George's Hill, from which a bird's-eye view of all the structures may be obtained. The depot, which is only one of the recent important enterprises carried out by President Scott, is 340x100 feet in size, fronting on Elm avenue, which separates it from the Centennial Grounds, and about 200 feet west of Belmont avenue. The central portion of the building is fitted up as a gentlemen's waiting-room, 100x130 feet, and west of this is a ladies' waiting-room, 80x100 feet. There are in addition a ticket-office, ladies' and gentlemen's retiring-rooms, a parcel-room, a baggage-room, and, in the gallery at the eastern end, offices for the superintendent and telegraph operators. The depot is about 300 yards distant from the main railroad. Three branch tracks, running from this to the depot, will be used respectively for trains from New-York, Baltimore and the West. The trains will stop at platforms on the southern side of the depot. Of these platforms, which are three in number, aggregating 55 feet in width, and 1650 in length, there will be one for each branch track. Departing passengers will enter the depot, and, having purchased their tickets, proceed by one of three

passage-ways to the particular train which they may wish to board. Passengers will thus be readily classified, and enabled to reach the desired train without trouble. The trains will be so run that those arriving may be immediately reloaded with passengers, and near the main road are located a number of sidings, upon which may be placed trains not to depart as soon as they arrive.

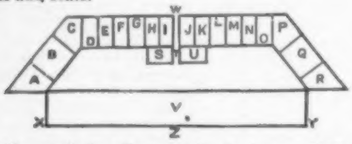
OPENING OF THE INTERNATIONAL EXHIBITION.

THE ceremonies of the opening day, May 10th, 1876, were grand, simple, and impressive. The magnificent front of Memorial Hall or Art Gallery formed the background for an immense open-air platform 400 feet long, on which were seated the President of the United States, the Emperor and Empress of Brazil, the Foreign Ambassadors, members of the Supreme Court, Senate, House of Representatives, Governor of Pennsylvania, and a great throng of other distinguished personages. Directly opposite the above, was another great platform set against the wall of the Main Exhibition Building, and here were located the musical performers. The space between the two platforms was filled with invited guests, while the spectators or general public crowded up at the ends of the platforms. The position of the platforms and of the grand assemblage of distinguished persons who assisted at the opening ceremonies, will be readily understood by reference to the general map of the grounds given on page 344. The space between the front of the Art Gallery and that part of the Main Building where the platforms were placed, indicated on the map by the word "Republic," is about 200 feet. For further reference, we give on this page a view of the Art Gallery, otherwise known as Memorial Hall, the beautiful south front of which was occupied, as stated, by the Presidential platform.

The main front, before which the ceremonies were held, displays main entrance in the centre, consisting of three colossal arched door-ways, a pavilion at each end, and two arcades connecting the pavilions with the centre. There is a rise of thirteen steps to the entrance. In the centre of the main frieze is emblazoned the United States coat-of-arms. A balustrade with candelabras surmounts the main cornice, and at either end is an allegorical figure representing Science and Art. Each pavilion shows a stained window 30 feet high and 12 feet wide, and is further ornamented with tile-work, wreaths of oak and laurel, thirty stars in the prize and a superincumbent colossal eagle. The arcades—a general feature in the old Roman villas, but entirely novel in this country—form promenades looking outward over the grounds, and inward over open gardens which extend back to the main wall of the building. The dome, rising 150 feet from the centre, is of iron and glass, and terminates in a gigantic bell, from which the figure of Columbia rises with outstretched, protecting hands. At each corner of the dome's base stands a figure of colossal size—the four figures typifying the four quarters of the globe. What with the lofty form of Columbia, the lower figures at the base of the dome, the still lower allegorical figures over the main cornice, and the outspread eagles hovering above the pavilions, the roof of the Hall bristles with sculptural emblems.

A larger engraving of this beautiful edifice will be found on page 25, No. 2, of our SUPPLEMENT.

The accompanying diagram exhibits the positions of the platforms and seats.



V, platform of the Centennial choristers, 1100 in number, and the grand orchestra of 150 members, under the leadership of Theodore Thomas. A C P R is a three-rowed tier resting against the southern front of Memorial Hall, W showing the position of the latter. The tier is over four hundred feet in length, and the width of the rows placed on a level would aggregate twenty-five feet. T, unoccupied space, leading from the main doors of Memorial Hall. Here the President of the United States, having passed through Memorial Hall from the northern entrance, made his appearance, escorted by Presidents Hawley, of the Commission, and Welsh, of the Board of Finance, and took seat at I.

A and B.—Women's Centennial Committee.
C.—Judges of United States Courts and officers of United States Executive Bureaus.
D.—Officers of the army and navy, Smithsonian Institution and Naval Observatory.
E.—The Governor, State Officers, Supreme Court and Legislature of Pennsylvania.
F.—The Governors of States and their Staffs.
G.—The National House of Representatives.
H and I.—The President of the United States, his Cabinet, and the United States Senate.
J and K.—The Supreme Court of the United States, and the Diplomatic Corps.
L and M.—The United States Centennial Commission, Board of Finance, Women's Centennial Executive Committee, Foreign Commissioners and the boards and bureaus of the Exhibition.
N and O.—The Mayor, Councils, and departments of the City of Philadelphia and Foreign Consuls.
P.—The Mayors of Cities and the Yacht and Rowing, Regatta and Rifle committees.
Q.—State Centennial Boards.
R.—The Board of Judges of Awards.
S and U.—The press.

The ceremonies were begun at the appointed hour, 10.15 A.M.

The orchestra and chorus having previously assembled, Mr. Thomas ascended at the appointed minute, and was greeted with a resounding cheer.

Lifting his baton, he initiated a series of hymns and marches, which during the next half-hour gratified visitors from every clime. The "Marseillaise," the "Wacht am Rhein," the Spanish, Austrian, Italian, British, and other national airs were performed.

A general and hearty "ovation" was extended to the Emperor of Brazil, who approached the platform with the Empress on his arm, both in plain costume, the Brazilian Minister at Washington, and members of the Brazilian Legation, following.

A slight interval: then the President of the United States and his Cabinet came forth from the central door of Memorial Hall, and advanced to the platform, the orchestra playing "Hail to the Chief."

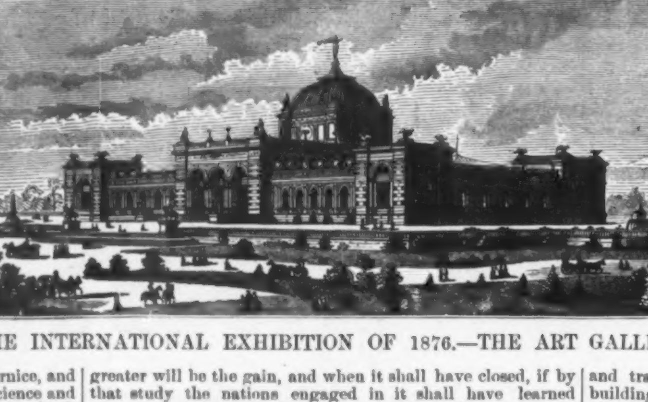
The new Centennial March, by the great composer Wagner, was then rendered with much effect.

A prayer by the Right Rev. Bishop Simpson was followed by the singing of the beautiful hymn by Whittier (published in our last SUPPLEMENT), with music by John K. Paine.

Mr. John Welsh, President of the Centennial Board of Finance, then arose and, in a brief speech, presented the buildings to the President of the Commission, concluding as follows:

"We congratulate you on the occurrence of this day. Many of the nations have gathered here in peaceful competition. Each may profit by the association. This Exhibition is but a school; the more thoroughly its lessons are learned the greater will be the gain, and when it shall have closed, if by that study the nations engaged in it shall have learned respect for each other, then it may be hoped that veneration for Him who rules on high will become universal, and the angels' song once more be heard:

"'Glory to God in the highest,
And on earth peace, good-will towards men.'"



THE INTERNATIONAL EXHIBITION OF 1876.—THE ART GALLERY.

General Hawley, President of the Commission, then delivered a short but excellent speech, addressed to General Grant, President of the United States, closing as follows:

"It has been the fervent hope of the Commission that, during this festival year, the people from all States and sections, of all creeds and churches, all parties and classes, burying all resentments, would come up together to this birthplace of our liberties to study the evidence of our resources; to measure the progress of a hundred years, and to examine to our profit the wonderful products of other lands; but especially to join hands in perfect fraternity, and promise the God of our fathers that the new century shall surpass the old in the true glories of civilization. And, furthermore, that from the association here of welcome visitors from all nations there may result not alone great benefits to inventions, manufactures, agriculture, trade, and commerce, but also stronger international friendships and more lasting peace.

"Thus reporting to you, Mr. President, under the laws of the government and the usage of similar occasions, in the name of the United States Centennial Commission, I present to your view the International Exhibition of 1876."

To which President Grant responded:

"MY COUNTRYMEN: It has been thought appropriate, upon this Centennial occasion, to bring together in Philadelphia, for popular inspection, specimens of our attainments in the industrial and fine arts, and in literature, science, and philosophy, as well as in the great business of agriculture and of commerce.

"That we may the more thoroughly appreciate the excellencies and deficiencies of our achievements, and also give emphatic expression to our earnest desire to cultivate the friendship of our fellow-members of this great family of nations, the enlightened agricultural, commercial, and manufacturing people of the world have been invited to send hither corresponding specimens of their skill to exhibit on equal terms in friendly competition with our own. To this invitation they have generously responded; for so doing we render them our hearty thanks.

"The beauty and utility of the contributions will this day be submitted to your inspection by the managers of this Exhibition. We are glad to know that a view of specimens of the skill of all nations will afford to you unalloyed pleasure, as well as yield to you a valuable practical knowledge of so many of the remarkable results of the wonderful skill existing in enlightened communities.

"One hundred years ago our country was new and but partially settled. Our necessities have compelled us to chiefly expend our means and time in felling forests, subduing prairies, building dwellings, factories, ships, docks, warehouses, roads, canals, machinery, etc. Most of our schools, churches, libraries, and asylums have been established within a hundred years. Burdened by these great primal works of necessity, which could not be delayed, we yet have done what this Exhibition will show in the direction of rivalling older and more advanced nations in law, medicine, and theology; in science, literature, philosophy, and the fine arts. Whilst proud of what we have done, we regret that we have not done more. Our achievements have been great enough, however, to make it easy for our people to acknowledge superior merit wherever found.

"And now, fellow-citizens, I hope a careful examination of what is about to be exhibited to you will not only inspire you with a profound respect for the skill and taste of our friends from other nations, but also satisfy you with the attainments made by our own people during the past hundred years. I invoke your generous co-operation with the worthy Commissioners to secure a brilliant success to this International Exhibition, and to make the stay of our foreign visitors—to whom we extend a hearty welcome—both profitable and pleasant to them.

"I declare the International Exhibition now open."

Salutes of cannon and chimes of bells followed, and soon the chorus of "Hallelujah" by all the orchestra and singers. The last note of the "Hallelujah" was the signal for the march into the Main Building, headed by President Grant and the Director-General.

THE OPENING PROCESSION.

We follow the description given by the New-York *World*: "Swinging open, the doors disclosed from the most advantageous point of view the interior of the Grand Central Pavilion, 120 feet square and nearly 100 feet high, surrounded and partly occupied by the richest exhibitions of the United States, Great Britain, France, and the German Empire. At each of the four angles, winding staircases lead up through airy towers to lofty balconies, where throngs of spectators had climbed to view the scene. The interior is painted with brilliant vermilion and azure blue upon a ground of maroon, and the southern windows and the roof-trusses are vivid with color.

"High up above the balconies, against the four interior friezes of the pavilion, hang the magnificent trophies of Europe, Asia, Africa, America, which have just been completed by Mr. Camille Picton, of Paris. They are each about 28 feet high and 60 feet wide or long."

And now, from either of the balconies overhead, there was presented a sight fit to improve the self-complacency of the whole Yankee nation. The twenty-one acres sheltered by a single roof, which lay to the east and west, were occupied by the exhibitions of thirty countries and their colonies, the richest and most powerful in the world. The transept, lined with decorated arches, gave passage to the procession, which, occasionally lost to sight under overhanging banners, moved slowly. The organs continued to thunder down the nave and aisles. Exhibitors from every meridian assembled in front of their respective spaces, saluted the visiting train. Back of them, extending over acres of floor-room to the walls, forests of pavilions, and jungles of show-cases, monuments and fountains bewildered and fatigued the eye. Here, in a single building of the Exhibition, were deposited articles valued at unknown sums, and some antiques from countries like Egypt and Italy were of course priceless.

From the eastern end the procession, headed by the President and General Hawley, turned and traversed the nave through the whole length of the building. For a little way to the right, and to the left of its march along the whole way back to the Central Pavilion, it moved past the Exhibition of the United States, which occupies over one fourth of the entire floor. Brazil, at whose dazzling mauresque pavilion her Emperor cast an interested glance as he moved by, presents a display of the precious stones, ores, woods and other products of each of the provinces of her immense territory. Farther on was Belgium, with a huge pulpit of carved wood for her *pièce de resistance*, from the ateliers of Goyers Frères, of Louvain. Next, Switzerland, her booths stocked with those rare curiosities with which half the world is familiar; and then France and her colonies.

The French display was instantly seen to consist (like the English) less in the array of glittering show-cases than in the systematic and tasteful arrangements of attractive articles.

Beyond the Central Pavilion, to the west, the procession moved altogether through foliage land. It must have seemed to General Grant somewhat like a review of the nations. Great Britain stood on the right, flanked by her colonies of Victoria, South-Australia, New-South-Wales, New-Zealand, Queensland, Jamaica, Bermuda, British Guiana, Trinidad, Bahama, the Gold Coast, the Cape of Good Hope, Mauritius, and Seychelles. A crimson banner, hoisted high, was emblazoned with the word "India."

On the left shone the exquisite objects in Bohemian crystal from Austria. Farms of glass, engraved, opaque, and clear cut; iridescent imitations of the Murano glass of Venita; wonderful hanaps of green glass painted in enamel, and behind them panels of painted and stained glass from Innspruck, the capital of the Austrian Tyrol—these charming things made dull their companion-works of china and bronze.

The procession halted for a moment at the inclosure of the Spanish Exhibition.

A triumphal gateway, triple-arched, in imitation of pink granite with bronze facings, comprises three entrance-ways draped with hangings of crimson and yellow silk. Above, the arms of Spain show in the centre of a gloomy trophy. Depending from the arch of the central entrance is a faultless candelabrum of oxidated silver and brass, in the Gothic style, contributed by the King. In the portico on either side are shown other articles sent over by young Alfonso, including samples of carved woods inlaid with gold, eight marvellous tapestries, vases of china and porcelain from the Royal Museum of Madrid, the most interesting of all armories. Starting out to the eye among the rest of the Spanish objects are the *azulejos*—the tiles resembling Italian mosaics, which the Moors and Arabs contributed long ago in Valencia to art.

In the Egyptian department, fragments of the most ancient monuments along the Nile are here, and copies of sculptured antiques gathered from ruins supposed to antedate the pyramids. Three lamps from the Mosque of Cairo hang in a case—three crystal lamps enamelled with gold, the art of making which perished 800 years ago. Here hangs, too, one of the very few real "Damascus blades" that have been preserved since steel was wrought to pierce like a needle and bend like a bow.

OPENING OF THE MACHINERY EXHIBITION.

A FAR-EXTENDING mass of people, shut out from the buildings during the opening ceremonies and anxious for a glimpse of the procession, pressed hard on the picturesque ranks. Flags waved, the bands struck up, and cheers were raised, until the privileged order of notables disappeared through the portals of Machinery Hall. Here the scene of luxuriant fabrics, textures, colors, ornaments, and articles of manufacture, education and science, which had charmed attention in the main building, was replaced by a concourse of genii. The gigantic arms of cranes and derricks lifted themselves nearly to the ceiling of the building, whose avenues stretched afar into shadow. Huge iron paws, crucified by spikes an inch thick to beams resting on the floor, were the supports of enormous creatures of iron, brass, and steel, their hoppers yawning for victuals. Strange mechanical forms crouched low along the nave, and here and there a piece of fanciful machinery, clad like the sewing-machine in glory of mahogany and gold, suggested a coquettish fay among giants. Ponderous cotton-gins and sugar-crushers, the most powerful hydraulic machinery, printing-presses, lathes, machines for

the manufacture of tools and wood-work and machines for the weaving of textile fabrics, lined the way, motionless. The building was oppressed with stillness and lack of movement.

There was never a more doleful march than that of the dignitaries of to-day up through the hall to the transept where the Corliss engine appeared in repose. Surrounding this stupendous object seven railroad locomotives stood, and numerous massy piles of stationary mechanism. On the floor were strewn sundry playthings for Titans, such as an iron shaft $33\frac{1}{4}$ feet long and 22 inches in diameter, weighing $22\frac{1}{4}$ tons, and an iron armor-plate 23 by 9 feet. The engine Cyclopean, overshadowing, towered to near the lofty roof. Seven hundred tons of metal were used in its construction. Its driving-wheel is 25 feet in diameter. Its cylinders are 44 inches in diameter and of 10 feet stroke. Around it, looking like pigmies, the procession clustered.

Within the railing of the engine were assembled all the principal officers of the Exhibition, the President and his Cabinet, and the Emperor and Empress of Brazil. Mrs. Grant, who had lingered with the Emperor while the President supported the Empress, was present in modest robes. At last General Hawley waved the spectators away from the immediate neighborhood. The guests within the railing drew aside, leaving the President and Mr. George H. Corliss together in the centre. "Now, Mr. President," said Mr. Corliss. "Well," said the President quietly. "How shall I do it?" "Turn that little crank around six times." General Grant made a motion with his fingers inquiringly, "This way?" "Yes." In another half minute the screw was turned by General Grant, the colossal machine above him began to move, the miles of shafting along the building began to revolve, several hundreds of steel and iron organisms were set going, and a visitor who retraced his steps could examine the processes of half the important manufactures on the globe. Thence the President and a number of the invited guests proceeded by way of the north main aisle to the doors of the eastern tower and to the Judges' Pavilion. There the President held a reception, intended to be brief, but which was considerably prolonged by the rush of the people.

INCIDENTS OF THE OPENING.

In about five minutes after the formal opening the Exposition grounds had swallowed up the great crowd which for three hours had been riding roughshod over rules, regulations and militia bayonets. Fairmount was populous everywhere and all at once, but nowhere crowded. The Main Building, with matter of 10,000 people in it, was no more crowded than St. Peter's; the great rush of belting and whir of wheels in the Machinery Building ran in spaces empty but no emptier than the floors of a great factory, and the floor of the Machinery Building supplemented the throng of the Main Building with a nearly equal crowd of gazers. The walks were full, but no more than full, and great spaces before the improvised platform, where men had stood in dense ranks packed by the thousand, were bare and solitary. No more signal proof of the size of the great show is likely to come before the Fourth of July, and it is barely possible that the throng then will not equal the gathering of to-day.

THE NUMBERS IN ATTENDANCE.

The automatic turn-stiles show the number of visitors registered at 250,000, an attendance which puts the success and the magnitude of the opening beyond question or cavil. Of this multitude the roads brought 75,000 The returns of the Reading Railroad give 35,000 as its share, the Pennsylvania road claims 20,000, and other smaller routes make up the rest. Of the 250,000 at least 225,000 were paying admissions, so that the receipts of to-day will amount to over $100,000. From first to last, in numbers, in magnitude, in completeness, the great opening was a great success.

For the foregoing particulars we are indebted to the New-York *World*; and for the excellent map of the grounds, given on page 344, we are indebted to the New-York *Times*.

THE INTERNATIONAL EXHIBITION OF 1876.

THE great Corliss engines now maintain the standard rate of 35 revolutions. The main driving-belts are all in place, and the immensely long lines of shafting have all been put in motion. The smooth and noiseless manner in which the great engines perform, as well as the perfect running of the bevel gears and shafting throughout, is the admiration of all who have witnessed them in motion. There have been many predictions of great and disagreeable noise to arise from the operation of the large number of heavy iron gears in contact on these lines of shafting; but they have fallen very short of fulfilment, for, beyond a very slight rumble, there is nothing to be heard from them. The Corliss engines and the whole arrangement of shafting connected with them will be pronounced by all to be a most admirably conceived and masterly executed piece of work. Among the work of the Bureau of Machinery which is entitled to special consideration, are the long lines of steam-pipes, the dimensions and extent of which I have given in previous letters. A contract was entered into with the National Tube Works of McKeesport, Pa., for the preparation and erection of this work. As an exhibit merely, it would constitute so much of a novelty, that it seems almost a pity to encase them with the indispensable non-conducting covering. These pipes are in diameter from 15 inches downward, and are, from the smallest to the largest, *lap welded*. Hitherto, steam-piping of over 4 or 5 inches in diameter has been made either of cast-iron or riveted boiler-plate; but these works now turn out all sizes, from 18 inches down, lap welded. And, moreover, all the unions and flanges are screwed to the pipe precisely as in the ordinary and smaller sizes of steam and gas pipe. It is no less than a triumph of mechanical construction to produce a perfect screw-thread by means of taps and dies—as these are—on a pipe, or within a flange or union of 15 inches in diameter; and these threads are as perfect throughout as can be found upon a piece of $\frac{1}{4}$ inch gas-pipe. A felicitous conception of this firm, in the erection of their steam-pipe lines, is that, wherever a reduction in diameter occurs, the flange which comes upon the smaller pipe is bored and tapped eccentrically, and placed in such a way that the lower sides of the bore of the two are in a right line, which, with the proper inclination for drainage, obviates the collection of pools of condensed water in a considerable length of the larger pipe near the points of reduction, as is inevitably the case where the smaller is concentric with the larger pipe. The pipes being in this way always kept thoroughly drained, the disagreeable cracking noise usually attending the admission of steam to pipes containing these pools of cold water is entirely avoided. In addition to the large amount of piping of all sizes which will be in actual service, this Company exhibit specimens of all their variety of work in a very extensive way, showing the improvements peculiar to them, and among which is a lap-welded pipe, threaded and flanged, of 18 inches diameter.

This piping is all covered with the "air-space" non-conducting covering of the Chalmers Spence Co. of New-York, which, although now quite largely in use, may be acceptably described. This covering consists of a coarse wire netting surrounding the pipe, kept from contact with it by a number of studs or thimbles formed of sheet-iron and fastened to the interior of the netting, keeping it at about one inch from the pipe. Upon this netting a plastic non-conducting material is placed, to a sufficient thickness, varying according to the character of the pipe to be covered. The meshes of the wire netting, after the manner of lath to the plaster of a house wall, securely holds the plastic material in place after hardening. This is their ordinary method, but various other kinds of covering are placed upon the wire, such as webs of different fibrous materials. In the case of the piping above described the netting is surrounded with the ordinary hair felt, and the latter covered with canvas and painted. This combination makes a most perfectly non-conducting covering. The stratum of air between the pipe and wire netting offers the most effective resistance to the escape of heat by conduction, while the felt and canvas effectually obstructs the passage of that which is radiated through the air stratum.

Near the west end of Machinery Hall the Utica Gauge Company make an interesting and novel exhibit. They display several revolution counters and gauges of most elaborate finish, and having engraved upon them beautifully executed representations of the several principal exhibition buildings, besides a large number of the different sizes of instruments peculiar to this firm. They also have one of Wood's test pumps and "square-inch valves" for the purpose of testing gauges. This instrument is fitted up with the utmost accuracy, and is a most creditable specimen of modern perfection of workmanship and fine finish. A description of it is hardly necessary, inasmuch as it has been quite fully illustrated in the SCIENTIFIC AMERICAN of a recent date. The principal novelty in this exhibit is an instrument by means of which the revolutions of the Corliss engines will be recorded at a distance of about 450 feet from them. It resembles the ordinary revolution counter exteriorly, with index wheels presenting the digits in succession at the openings in the face in the usual way. In this instrument, however, motion is imparted to the wheels by clock-work, actuated by the customary spring, and governed by mechanism similar to that of the electric fire-alarm instrument. The apparatus is suspended, by means of an ordinary leather strap, from a slender bracket attached to their show-case, and ingeniously concealed in the strap are copper wires making electrical connection with the bracket, and a battery concealed within the show-case. From the bracket a wire is led through the building to a point at the engine such that at every revolution the galvanic circuit is completed, and thus the unit-wheel in the counter is made to indicate precisely as when the ordinary instrument is operated by direct mechanical attachment to some reciprocating part of the engine. Aside from the practical value of such a contrivance, this particular arrangement of it, exhibiting a simple cylindrical instrument suspended by a mere strap, without visible connection with and about 450 feet from the machine whose movements it is indicating, will be quite a curiosity. A little east of the Corliss engines, in the space of Mr. James Watson of this city, is shown an ingenious and valuable improvement in the machine tool known as the "gap lathe." These machines are intended for turning face-plate work of considerably greater diameter than can be swung clear of the general level of the shears, and to permit of this it is provided with a considerable depression or "gap" in the shears for a short distance from the face-plate. In the ordinary "gap lathe" a separate piece is fitted to this "gap," to be used whenever the saddle and tool post is required to be used in closer proximity to the face-plate than is possible with the gap piece left out. The improvement of Mr. Watson consists in dispensing with the gap piece and the time and labor of placing and removing it, by forming at the bottom of the "gap" an auxiliary shears, just as though the part of a continuous lathe-shears which would be removed to form the gap were simply lowered to the level of the bottom of the gap; and upon an extension of the saddle reaching down to the lower level the proper bearing pieces are made, such that, as soon as the saddle begins to leave the upper surface of the shears, it becomes supported at the lower surface, thus permitting of its travel throughout the entire limit of the length of the lathe without change. All who have had occasion to use this kind of lathe in establishments of too moderate extent to keep a large lathe exclusively for face-plate work, and for whose special use the "gap lathe" is intended, will appreciate this modification of it as a radical improvement.

J. T. H.

GAS ENGINES.

IN the German Department of Machinery Hall, Messrs. Lange & Otto have now erected and ready for operation five of their "Atmospheric gas engines," ranging from $\frac{1}{2}$ to 3 H.P., and a petroleum engine of similar design. They have also a 1 H.P. gas engine in the Main Building to furnish power for a printing press in the exhibit of the *London Graphic*.

The gas engine, although so far as yet perfected considerably inferior in point of economy of fuel to the steam engine—even to the small and consequently most expensive form of the latter, and with which it alone is in competition—possesses so many advantages over them, that they have lately come into quite common use. Their cost for fuel, too, in European countries, where gas is almost always to be had either of better quality or cheaper, is less marked than in this country, where it is either poorer or dearer, as compared with coal. The cost of fuel, however, does not by any means represent the true cost of the power obtained from them, for among the cheapening features in almost all engines of this class are the following: They occupy less space than a steam engine and boiler of equal power; they require less costly attendance; there is no fuel consumed while not in motion—a very important item where power of an intermittent character is required—a considerable consumption of fuel taking place in the furnace of a steam boiler which is principally wasted through the chimney and through radiation while not in actual use; they cause no trouble nor expense in the removal of ashes and refuse; they are always ready to be started at a moment's notice—another quite important consideration—and they are practically safe from destructive explosion. For all purposes, therefore, requiring small powers, it is fast becoming a quite formidable competitor with the steam engine; and, everything considered, it may be questioned if the steam engine of small power is really the most economical. Messrs. L. & O. claim to have over 3000 of their engines now in use, which is of itself one of the stubbornest of arguments in their favor.

This engine differs very materially from the Lenoir, Brayton, and other gas-engines; and in several respects it may be regarded as an advanced step towards the solution of the grand problem of the day, which, more than any other, is exercising the thinking minds of our time—that of converting the potential energy of heat into work. In this machine a mixture of atmospheric air and ordinary illuminating gas, in the proportion of about 12 to 1—which gives the requisite amount of oxygen for complete chemical combination with both the hydrogen and carbon contained in it—is admitted below the piston in a vertical cylinder of very considerable proportions as compared with the power developed. A small slide-valve actuated by suitable mechanism from the shaft, having the form of an oblong hollow box, with certain perforations in both of its sides, slides, gas-tight, within a casing which surrounds it on all sides except the top. One side of the valve-casing communicates with the under side of the piston, and the other side with the outer air. Near to the outer side of the valve a small jet of gas is kept burning. The perforations in the casing and valve are so arranged with reference to each other and to the motion given the valve that at the proper times the mixture is admitted beneath the piston in definite quantity, the gas to the interior of the valve, communication made first between the burning jet and interior of valve, at the next instant between the latter and the under side of the piston, and lastly between the bottom of the cylinder and the outer air. In this way the mixture is admitted, fired, and exhausted. Compared with the volume displaced by the piston in a stroke, the quantity of mixed gas and air admitted is very small, and when fired the expansion of the gases due to the heat developed by the combustion drives the piston upward very rapidly, displacing the air above it; and, continuing on, by virtue of its momentum, so far expands the gaseous contents of the cylinder as to reduce the temperature and pressure of the products of combustion and free nitrogen remaining in the cylinder to a sufficient degree to cause the condensation of that considerable part of them which exists as vapor of water, forming at the upward end of the stroke a partial vacuum beneath the piston; when the return or downward stroke is effected by the external pressure of the atmosphere. As the downward stroke progresses, the pressure of the carbonic-acid gas and nitrogen within the cylinder increases until it exceeds that of the outer air, when exhaustion takes place, and admission of a new charge of the mixture follows.

The piston-rod is in form of a rack and gears with a toothed wheel which works freely upon the shaft, the latter running in proper bearings on the upper end of the cylinder. This toothed wheel forms a part of a clutch-box, such that, during the upward stroke of the piston, the wheel turns upon, and in the reverse direction to that of, the shaft, and upon the downward stroke a gripping pawl within the box causes the piston to give motion to the shaft. Thus the engine is single-acting, and the piston, while imparting motion to the shaft, is never subjected to any greater than the atmospheric pressure; and the unbalanced pressure progressively diminishes as it descends. The cylinder is surrounded by a water-jacket, in which, however, the water is not renewed by circulation, but only as it becomes evaporated from the very small surface exposed. The gases, on the upward stroke, are expanded to that degree that while in constant use the temperature of the water in this jacket never exceeds 70° Fahr.; and as the evaporation does not exceed one quart of water per day for a 1 H.P. engine, the loss of heat in this way is very small. The temperature within the cylinder at the time of firing the charge is not less than 1000°, while that of the exhausted gases is about 65° Fahr., a range which is had in no other heat engine at present known. It may, therefore, be concluded that, so far as the work actually performed upon the piston during the upward stroke of the engine is concerned, the conversion of heat into work is very perfectly performed within the cylinder of this machine; and it would seem at the first glance that the useful work obtained from it should be at a very low cost for fuel. The inventors, however, claim for it no better than 1 H.P. per hour by the consumption of from 28 to 30 cubic feet of gas of fair quality, and not too highly carburetted; and if the motions of the engines be traced throughout a revolution, it will become quite apparent that, although the conversion of heat into work is so thoroughly done during the upward stroke of the piston, the energy being expended in displacing the atmosphere, a fraction only of which is utilized in rotating the shaft upon the downward stroke, the useful work obtained becomes small. Then the whole work done is small compared with the amount of surface rubbed over in the two strokes of the piston, which must make the friction of the machine bear a very considerable ratio to the indicated work done upon the piston. In this way probably the energy actually derived from the combustion of the gas is, through these obstacles, largely absorbed into useless channels. If, however, an H.P of useful work is obtained from it per hour, by the consumption of 30 cubic feet of gas, as is claimed, it is at least one of the most economical in fuel among this kind of machines, which, together with the advantages already enumerated as belonging to gas-engines generally, must make them a very desirable machine for many purposes.

The Brayton gas-engine appears in another part of the Hall in a much improved form. The engines hitherto exhibited by this inventor have been single-acting, and the mixture of gas and air has been kept under pressure in a reservoir, which has detracted a little, in the opinion of some, from its entire safety. The engine now on exhibition, however, is a double-acting beam-engine, and the reservoir contains under pressure atmospheric air only; the admixture being made during its passage from the reservoir to the cylinder. In this engine the range of temperature within the cylinder, during a stroke, is not nearly so great as in the Langen & Otto engine, and a much greater amount of heat is carried off in the water circulated about the cylinder, necessitated by the higher mean temperature within it; but that part of the heat which is transmuted into work is so much more perfectly utilized that the cost in fuel of a unit of useful work will probably not differ to any great extent in these two machines. In fact, the claim of the competitors as to economy of fuel varies so little that, if found out on trial, their comparative efficiency as small motors must depend very largely upon the value to be placed upon their other salient features.

The Brayton machine is a fine piece of workmanship, and in its working is smooth and equable, resembling in all respects, externally, a well-proportioned steam-engine. The Langen & Otto engine, however, looks like any thing rather than it, and in its action is widely different. When the charge is fired beneath the piston, the latter, with the rack attached, is shot upward with great velocity, descending slowly while in connection with the shaft, giving to it a very irregular and uncomfortable appearance, causing a kind of vague fear that the whole piston and rod or rack might be projected from the cylinder. After a little watching of it, however, this feeling wears off, and as the sudden impulses given the piston are found to recur with perfect regularity, one begins to have confidence in it, and to believe that this, as well as the Brayton machine, is an ingenious and creditable piece of work.

J. T. H.

IRON ASSAYING.

By Bruno Kerl, Professor at the Royal School of Mines, Berlin.

(Continued from page 282.)

Next in order in the processes under description is :—(6) *Solution of the Ores, &c.*—Substances are divisible into two classes, according to the ease or difficulty with which they are dissolved. Among those easily soluble are spathic ore, brown hæmatite, magnetic ore and bog-ore. Red hæmatite and the clay-ores are dissolved with difficulty, and form a class apart. The first step towards obtaining a solution is to reduce the ore to a powder, more or less fine, and digest it for a longer or shorter period with hydrochloric acid, either ordinary or fuming. The process of digestion is carried out in a covered porcelain dish or glass flask (fig. 10), placed, as shown later on in fig. 29, upon a piece of wire gauze above the burner, and covered over with a watch-glass or funnel. The digestion is continued until complete solution is effected, or until only a white insoluble residue is left at the bottom of the flask. If organic substances are present, as, for example, in blackband and in many clay-ironstones, the finely-divided ores must be heated for half an hour with the acid, or they may be ignited beforehand at as low a temperature as possible to burn off the organic substances. The work of solution with substances difficultly soluble is sometimes carried on under pressure, the flask being closed with a perforated india-rubber stopper, carrying a tube with a double bend, the longer arm dipping for from five to eight centimetres of its length in mercury.

It may be requisite to guard against the peroxidation of the iron by excluding the air. To this end the following expedients are adopted :—

(*a*) A few grains of sodic carbonate are added to the acid, the ore is thrown in, and the flask is closed with a perforated india-rubber stopper. This stopper receives one end of a glass tube bent twice at right angles, the longer arm dipping into a beaker filled with cold water, from which the air has been expelled by boiling. After solution, when the flame is removed from beneath the flask, water is forced in, and the dilution requisite for assay can thus be effected.

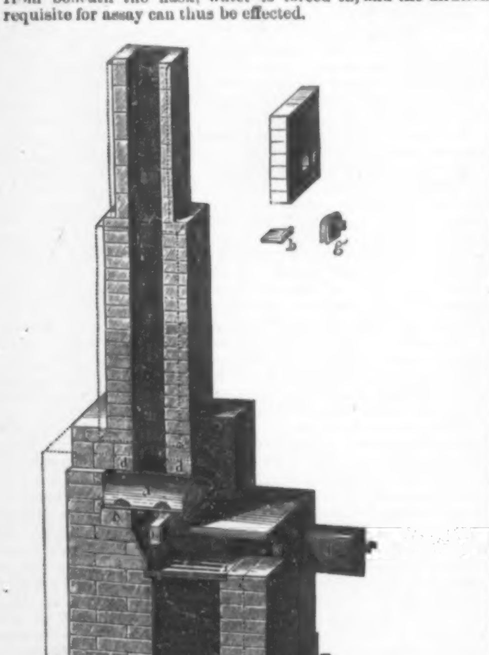


Fig. 9.—*a*, muffle, 36.6 cm. long, 17.6 cm. high, and 34.2 cm. wide; *b*, bearer; *c*, bedstone; *d*, arch; *e*, flue, 14.7 cm. broad, and 3 to 4 inches high; *f*, muffle-opening, 12 cm. wide, and 14.6 cm. high; *g*, stopper; *h*, stopping-piece for the aperture above muffle; *i*, fireplace, 26.8 cm. broad, 51.4 cm. long, 28 1 cm. under the muffle; *k*, working hole; *l*, door of ditto; *m*, ash-pit; *n*, *o*, *p*, air-passage, opening into outer air; *q*, damper; *r*, door of ash-pit.

(*b*) The same end is effected by the india-rubber valve, the form of which is given in fig. 11. The gases evolved during the operation pass out by the aperture at *f*. On their ceasing to pass, the opening is closed by the pressure of the outward air, that within the apparatus having been rarefied.

(*c*) Again, coal-gas, or hydrogen or carbonic acid gas—the two last generated, *e.g.*, in Kipp's apparatus, as showing in fig. 12—are introduced. The gases are first of all passed through a bottle containing a solution of cupreous chloride with hydrochloric acid and copper chips, for the absorption of oxygen, then through a washing bottle with a solution of sodic carbonate for retention of acids, and finally through its perforated cork to the bottom of the boiling flask, containing the ore and its solvent, which is placed slantwise over the source of heat. A second bent tube in the cork dips with its longer leg into a beaker of water, which cuts off the air, as in the apparatus devised by Fuchs for the assay of iron.

(*d*) Solution of the substance in a water-bath. Here the crucible, dish, or other vessel, is placed in a grooved and perforated covering ring, and a glass funnel fitted into the groove. The water that collects in the latter forms a seal against the air. Carbonic acid is introduced sidewise, and led over the surface of the water at both the beginning and the end of the operation, in order, in the former case, to expel the air, and, in the latter, to effect cooling. Carbonic acid is likewise introduced, when, on the withdrawal of the lamp, the fluid has to be stirred. The stirring takes place through the tube of the funnel by means of a platinum wire.

(7) *Fluxing.*—Ores such as some varieties of red hæmatite, specular ore, titanic and chromic ores, insoluble in acids, are rendered soluble by one of the following processes.

(*a*) The substance, having undergone a preparatory drying at 100 deg. Centigrade, is placed in a platinum crucible with four or five times its weight of white flux. The crucible is placed over a common Bunsen burner for half an hour, or over a blast-lamp (fig. 6) for ten minutes. The sides of the crucible are subjected to pressure on cooling and the contents are turned into a large beaker together with from twenty to thirty times their volume of water, then placed upon the water-bath and hydrochloric acid added till effervescence ceases; what was left behind in the crucible is washed out with dilute hydrochloric acid and added to the solution in the beaker. Complete solution ensues, unless the ore is a silicious one, when gelatinous silica remains undissolved. This, when it is only intended to determine the iron, is disregarded. When, however, filtering is necessary, or the silica has to be estimated, the solution is evaporated to dryness in the water-bath, in a platinum or porcelain dish, until all acid fumes have ceased. It is then heated for a time up to 120 deg. Centigrade in the air-bath, moistened uniformly with hydrochloric acid, and warmed for half an hour in a covered vessel. Hot water is now poured in, the whole is stirred, and the silica, thus completely separated, is filtered off, or the supernatant fluid is decanted, and the silica thrown upon a filter and washed with hot water. The silica is then heated and ignited, and should after this be tested for its freedom from unaltered ore. This is shown by the silica leaving no residue on treatment with hydrofluoric acid, or ammonium fluoride. The residue, if any, is dissolved in concentrated hydrochloric or sulphuric acid, and added to the original solution. If insoluble, it may be melted down with hydro-potassic sulphate to detect titanic

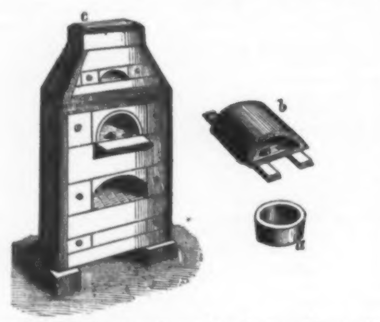


Fig. 8.—*a*, capsule; *b*, muffle, 14 cm. long, 7.5 cm. high, and 9 cm. wide.

acid, dissolved in water, filtered, and the filtrate boiled, a stream of carbonic acid being led through it, and water being added as the solution boils away. The titanic acid precipitated is recognizable by the violet color of a bead of microcosmic salt in the reducing flame.

(*b*) The substance is fused with from five to six times its volume of hydro-potassic sulphate. To the fused salt in the platinum crucible fine powdered ore is added ; a gentle heat is first applied, increasing till decomposition takes place, which is usually in about half an hour. The crucible is left to cool, and turned into a beaker, hot water with a little sulphuric acid being added, and the whole heated. A clear solution is formed, if neither silica nor titanic acid be present. If the latter occur, cold water dissolves the mass, the titanic acid being precipitated on boiling. The silicic acid is filtered off, and the remaining constituents are estimated in a sulphuric acid solution.

(*c*) The sample of ore is ignited for fifteen or thirty minutes in a porcelain crucible, the lid of which is perforated to admit a porcelain tube so that coal-gas hydrogen may be passed over the contents. The gas reduces the iron, and renders it soluble in hydrochloric acid.

(*d*) Insoluble silicates, the alkalies of which (as in clay, ashes, etc.) have to be estimated, are decomposed by ammonium fluoride. Seven or eight volumes of this are mixed with one of the finely powdered silicate in a platinum crucible, and made into a pasty mass with a very little water. The mass is placed in the water-bath and kept carefully

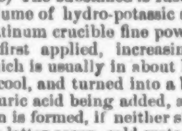


Fig. 7.

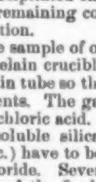


Fig. 10.

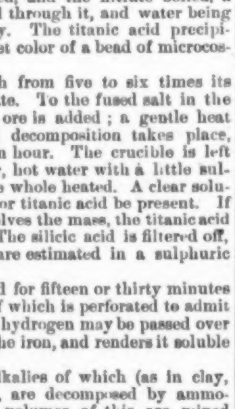


Fig. 11.—*a*, flask, holding 100 cubic cm.; *b*, india-rubber stopper; *c*, *d*, india-rubber tube with slit in the middle, reaching below to above glass tube, closed above by glass rod, *e*.

stirred with a platinum spatula to complete dryness. It is then heated over a Bunsen burner till it ceases to fume. Concentrated sulphuric acid is added, and the mixture heated to drive off excess and then dissolved in hydrochloric acid. If any insoluble residue be found, deficiency of ammonium fluoride or excess of water is indicated, or slovenly stirring or the presence of sulphate of barium may be inferred.

In the analysis of blast-furnace slags it is recommended* to heat them, together with three or four times their volume of ammonium fluoride, and gradual addition of sulphuric acid, in the water-bath, till ebullition ceases, and then in the sand-bath till the sulphuric acid begins to fume. The crucible is cooled, and rinsed with water ; filtration and washing follow ; and, finally, the reduction of the oxide of iron in the filtrate by zinc, and titration with potassic permanganate.

(*e*) When the protoxide, together with the oxide, has to be estimated in silicates (ores, slags, etc.), the two (*e.g.*, 0.5 gr.) are mixed with fluor-spar, in which no iron is present, or with cryolite. The mass is saturated with hydrofluoric acid, so that the platinum crucible is about two-thirds full of the fluid ; the crucible is heated in the water-bath, its contents being kept in contact with coal-gas or carbonic-acid gas. If this plan be not adopted, a mixture of hydrofluoric acid and concentrated sulphuric acid may be made use of for determining the constituents in the manner mentioned above. Or some 0.5 gr. of the substance may have 10 cubic centimetres of sulphuric acid of 1.34 sp. gr. poured upon it in a glass tube closed at one end and drawn out a the other. This end is

Fig. 12.—*C*, glass globe receiving dilute hydrochloric acid through tube, *e*, passing it into *A*, whence it rises, in contact with carbonate of lime or granulated zinc into *B*, evolving carbonic acid or hydrogen, which gases are led off by the tap, *d* ; *a*, stopped tube for emptying *A*.

afterwards sealed, and the tube heated up to 250 or 300 deg. Cent. for about ten hours in a paraffin bath. After the substance is decomposed, the end of the tube is broken off, the contents are thrown quickly into water, the tube is rinsed out, and the protoxide is titrated and so on. Silicic acid remains behind after the dilution with water.

* "Berg- u. hüttenm. Z." 1872, p. 113.

NEW OXIDE OF SULPHUR.

For many years it has been known that the action of the sulphur on sulphuric oxide or on disulphuric acid produces an intense blue color. R. Weber has successfully investigated the cause of this color, and has shown that it is due to a new oxide of sulphur which he has isolated. To prepare it, a portion of sulphuric oxide is prepared, containing some sulphuric acid, and into this is thrown, in small portions, carefully dried flowers of sulphur. At the instant of contact the sulphur is converted into dark blue liquid drops which sink to the bottom of the liquid and there solidify. Care should be taken to keep the temperature at 15° C., since below this point the whole liquid solidifies, and above it the blue body decomposes. After the operation, the excess of liquid is poured off, the blue crystalline crusts are drained and the excess of sulphuric oxide driven off at a temperature not exceeding blood heat. Bluish green crusts are thus obtained, which are very friable and which have a structure similar to malachite. They decompose without fusion slowly at ordinary temperatures, more rapidly on heating, evolving sulphurous oxide and leaving sulphur behind. In a cool place the decomposition is so slow that the substance may readily be weighed for analysis. Moist air decomposes it rapidly and it hisses when thrown into water. Alcohol and ether decompose it, and set free sulphur. A mean of five closely accordant analyses showed that it contained 57.12 per cent of sulphur. The author names it sulphur sesquioxide or dithionic oxide. No compounds of it have yet been made. Selenium gives an analogous compound. It is dirty-green in mass, yellow in powder.—*Pogg. Ann.*

JOHN FITCH.

The Louisville *Courier-Journal* contains the following letter:

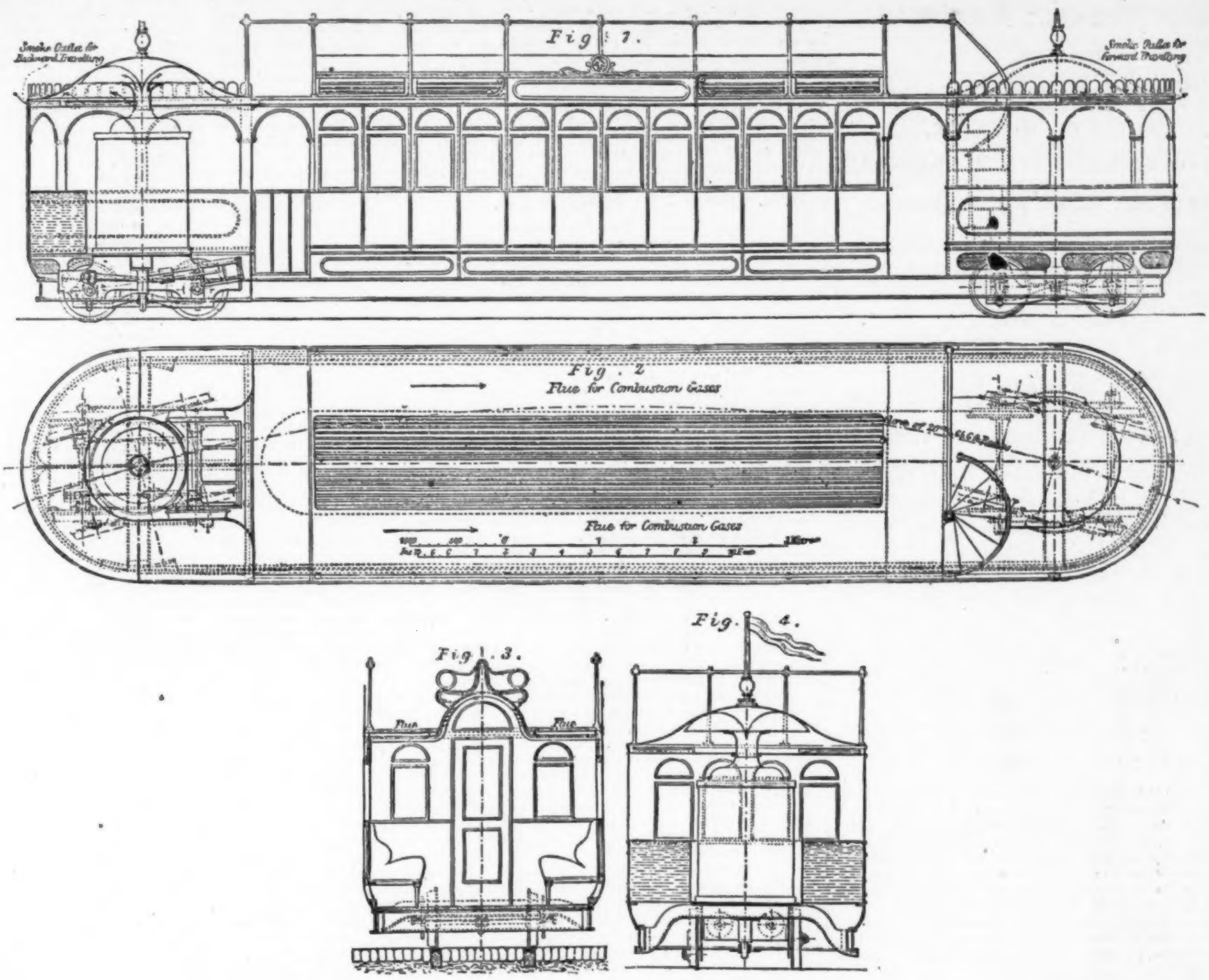
Bardstown, April 8, 1876.—In one corner of a long-disused burying-ground in this place lies all that is mortal of one of the greatest men not only of Kentucky and America, but of the world. I refer to John Fitch, the inventor of the steamboat. Mr. Fitch lived and died in this place, and is buried in the rear of the jail of the county, without even a stick to mark the spot of his "last, long repose."

His invention was studied and perfected in this place, and he made three separate trips to Philadelphia (then the seat of government), walking each time, going and returning, in order to obtain government aid to enable him to perfect his invention. But, meeting with nothing but rebuffs and incredulity, he finally abandoned his attempts, and left the fruit of his labors to be reaped by Robert Fulton, who, as is now acknowledged, obtained his ideas of a steamboat from one built by Fitch in Philadelphia, and which lay rotting on the bank of East River, New-York, for years after his death. All the inhabitants of this place who remembered Fitch are now dead. The last one, Mr. William Heavenhill, died in 1873. Mr. Heavenhill was the first white child born in Kentucky, and was born in a cave near this place while his father and his father's friends were defending the entrance against the Indians.

Mr. Heavenhill used to relate many stories of Fitch's life in this place, and of his invention of the steamboat. Among others, he used to tell of Fitch's first attempt at applying steam to water-navigation ; and he stated that Fitch generated the steam in a tea-kettle borrowed from his mother, Mrs. Heavenhill.

Fitch's experiments were conducted in the attic of a house which stood on the site now occupied by the residence of Felix G. Rogers, Esq., in this place, on the south-east corner of Market street and the public square. In using the tea-kettle referred to above, he confined the steam by placing the end of a board on the top of the kettle and wedging the other end under the rafters of the roof, and conducted the steam to his machinery through a pipe leading from the spout. On one occasion Fitch neglected to turn the stop-cock which let the steam on the machinery, and the roof was raised and lowered several times by the force of the steam in the kettle. As the steam raised the lid the plank lifted the roof, and the escape of the steam then lowered it again, when it was again raised and lowered.

Fitch's first model floated on a pond which then occupied the north-east corner of Third street and Public square, where Cary's drug-store, Talbott's tailoring establishment, and Newman's grocery now stand.



NEW STEAM STREET-CAR.

It is generally believed that Fitch's first experiments were made in Philadelphia, but such was not the case. His first attempts were made here, and his invention was perfected before he went East.

Fitch was regarded here, during his life, as a mild sort of madman, but to this popular belief there was one noble exception. Dr. Alexander McCown, a resident of this place, from the first believed in Fitch and in his boat. And when Fitch's scanty means were exhausted, he took him to his own house and supplied him with money with which to continue his attempts, and but for the death of Fitch both would have been amply repaid.

All of Fitch's models, drawings, etc., were burned in the house of Dr. McCown, which stood on the corner of Main and Third streets, in this town, and which was set fire to by an enemy of the doctor's about 1810. Fitch's boat, according to the account handed down in this place from father to son, was moved by means of twelve paddles, six on each side, which paddles were attached at right angles to a horizontal bar on each side of the boat, and the bar was moved back and forth by the piston-rod of the engine.

In 1788 Fitch made a practical test of his invention over a mile course of the river in front of Water street, Philadelphia. His boat was sixty feet long, eight feet wide, and four feet deep. He had on board the Governor of Pennsylvania and a number of the officers of the Federal Government; yet, although his test was in every way a success, the general government would extend to him no aid or encouragement. He conveyed his boat from there to New-York, hoping to get assistance there; but failing, he left his boat to rot on the shores of the Hudson River, and returned to his home in this place. This was his last effort to obtain recognition, and he then gave up all hope of ever reaping the reward of his genius, leaving it to future generations to place his name where it belongs—at the very head of the list of the benefactors of mankind. He died in this place early in the year 1798, and was buried by his friend, Dr. Alexander McCown, in the graveyard which now is in rear of the common jail of Nelson County. The day and month of his death are forgotten. The spot of his burial was unknown for years, but two years ago the deposition of a son-in-law of Dr. McCown's was found in the county clerk's office which establishes, beyond question, the site of his grave, which is marked only by the *depression* in the ground, caused by the settling of the earth with which his grave was filled.

His will, of which the following is an exact copy, is recorded in the Nelson County clerk's office:

"I, John Fitch, of the county of Nelson, do make this my last will and testament: To William Rowan, Esq., my trusty friend, I bequeath my beaver hat, shoe, knee, and stock buckles, walking-stick, and spectacles. To Dr. William Thornton, of the city of Washington, in the District of Columbia, to Eliza Vail, daughter of Aaron Vail, consul of the United States at L'Orient, to John Rowan, Esq., of Beardstown, son of said William, and to James Nourse, of said town, I bequeath all the rest of my estate, real and personal, to be divided amongst them share and share alike. And I appoint the said John Rowan, Esq., and James Nourse, Esq., my executors, and the legacies hereby bequeathed to them, my said executors, is in consideration of their accepting the executorship and bringing to a final close all suits at law and attending to the business of the estate hereby bequeathed. Hereby declaring this to be my last will and testament, this 20th day of June, one thousand seven hundred and ninety-eight, witness my hand and seal.

"JOHN FITCH. [SEAL.]

"Acknowledged, signed, and sealed in presence of
"JAMES NOURSE,
"MICHAEL RENTCH,
her
"SUSANNAH [X] MCCOWN."
mark.

The will was probated and ordered to record on July 10th, 1798, consequently Fitch's death must have occurred between the 20th day of June and the 9th day of July, 1798.

The grave of Fitch deserves some monument to tell the passer-by who sleeps beneath, and this communication is written with the hope of attracting the attention of some of the many gentlemen of your city who owe all that they own to the genius and skill of the greatest man of any century, country, or clime—John Fitch.

J. C. W., JR.

NEW STEAM STREET-CAR.

Designed by Mr. A. BRUNNER, Engineer, Berne, Switzerland.

WE annex engravings of a form of steam tram-car designed by Mr. A. Brunner, of Berne, on the Fairlie system. The particular car illustrated is adapted for a tramway of a metre gauge, but of course a similar arrangement could be adapted for other gauges. As will be seen from our engravings the body of the vehicle is carried by a main frame with semicircular ends, this frame resting on two four-wheeled trucks or bogies, one of which is fitted with steam cylinders. When the tramway to be worked includes very steep gradients it is intended that steam cylinders shall be fitted to both trucks, so that the whole weight of the vehicle with its load may be available for adhesion.

The wheel base of each truck is 3 ft. $11\frac{1}{4}$ in., and the chilled cast-iron wheels with which they are fitted are $23\frac{3}{4}$ in. in diameter; while the distance between the centres of the two bogie pins or centres is 31 ft. 6 in. The main frame which connects the two trucks is made of iron of I-section $8\frac{3}{4}$ in. deep, while the frame is, as will be seen, kept down very low, its underside being only 8 in. above the rails. This frame thus screens the moving parts of the steam bogie from sight, whilst its low position enables the centre of gravity of the whole vehicle to be kept down.

The manner in which the main frame and bogies are connected is as follows: The truck fitted with steam cylinders—or front truck as it is called for convenience, although the vehicle can, of course, run equally well in either direction—is provided with a strong transverse bearer as shown in the cross section Fig. 4, the ends of the cross bearer carrying steel slides upon which the main frame bears and moves. The centre pin of this bogie takes hold of a longitudinal drawbar which is fixed below the main frames as shown. In the case of the hind bogie, on the other hand, the transverse bearer instead of being fixed to the truck frames is fixed to the main frames, and carries a centre pin which enters into a suitable socket fixed to the truck frames. In this case the truck frames carry circular slides on which the transverse bearer rests. As will be seen from the plan the arrangement provides for the free movement of the trucks, and thus notwithstanding its length the vehicle can pass readily round curves of very short radius. If necessary, for repairs, the main frame can be readily lifted and the trucks removed.

The front truck is fitted with a pair of inside cylinders, the front axle being a crank axle. The valve gear (not shown in our engravings) is of the Allan straight-link type, and the wheels are coupled by side rods in the usual way. The truck carries a vertical boiler, and this boiler is fixed to the truck and moves with it, so that there is no necessity for jointed pipes in making the connexions to the cylinders. The arrangement is in this respect similar to that adopted by Mr. Fairlie in the steam carriage constructed by him in 1869.

The principal dimensions of Mr. Brunner's tram-car and its machinery are as follows:

	ft.	in.
Diameter of cylinders	0	5.9
Stroke of pistons	0	11.8
Diameter of wheels	1	11.6
Wheel base of each bogie	3	11.2
Distance between centres of bogies	31	6
Total length of carriage	40	0
Width outside	8	2.4
" inside	7	10.4
Height inside at sides	5	10.9
" " centre	7	4.6
Heating surface of boiler	83 square feet	
Capacity of water tanks	220 gallons	
" " coal-bunkers	4 cwt.	
Pressure of steam in boiler	147 lb. per sq. in.	
Mean speed of vehicle	$6\frac{1}{4}$ miles per hour	

Tractive force exerted with a mean pressure in cylinders equal to 60 per cent. of the boiler pressure = 1485 lb.

Weight of vehicle in working order but without passengers, $8\frac{1}{4}$ tons.

Total weight fully loaded, 12 tons.

The front truck in Mr. Brunner's tram-car is fitted with a steam brake, and it also carries the water-tank, this being of U-form in plan, and arranged as shown in Figs. 2 and 4. A peculiarity in the design of the car is the provision made for the discharge of the products of combustion. When the car is moving with the steam truck in the rear, these products are simply discharged as shown by the arrows at the left-hand side of Fig. 1; but when the steam truck is in advance the gases are led through flues formed in the roof of the vehicle (see Fig. 3), and discharged at the rear. In winter these flues are turned to account for warming the vehicle, but in summer they are protected by a non-conducting coating, so as to prevent the radiation of heat.

The body of the vehicle we are describing rests directly on the main frames, and its floor is but $17\frac{1}{2}$ in. above the rail level. It consists of one long lower compartment, with longitudinal seats, accommodating twenty-four passengers, and a kind of pavilion situated over the trailing bogie, containing seats for seven others. This pavilion is intended to be used as a smoking compartment, and in it is also situated the staircase which gives access to the roof of the main or central compartment, there being on the roof seats for twenty-four other passengers. The vehicle thus carries altogether fifty-five passengers, namely, twenty-four outside, and thirty-one under cover. Two transverse passages, one at each end of the main compartment, give ready access to the vehicle, and serve also for the accommodation of the driver and conductor.

Scientific American Supplement.

No. 22.

FOR THE WEEK ENDING MAY 27, 1876.

PUBLISHED WEEKLY, AT THE

OFFICE OF THE SCIENTIFIC AMERICAN,

No. 37 Park Row, New-York.

MUNN & CO., Editors and Proprietors.

O. D. MUNN. A. E. BEACH.

The SCIENTIFIC AMERICAN SUPPLEMENT is uniform in size with the *Scientific American*. Terms of subscription for SUPPLEMENT, $5.00 a year, postage paid, to subscribers. Single copies, 10 cents. Sold by all newsdealers throughout the country.

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37 Park Row, New-York.

THE FRENCH EXPOSITION OF 1878.

THE following is the text of the French law authorizing the holding of an International World's Fair in Paris in 1878: "The President of the French Republic, on the report of the Minister of Agriculture and Commerce, decrees: Article 1. A universal exposition of agriculture and industrial products shall be opened in Paris on May 1st, 1878, and shall be closed on the 31st of October following. The products of all nations shall be admitted to this exposition. Article 2. A future decree will determine the conditions under which the exposition will be held, the regulations under which the goods will be exhibited, and the different kinds of products which are susceptible of being admitted."

It is announced by the French daily journals that a Commission has already been appointed to attend to preliminaries, and that the locality of the exhibition will probably be the same as that occupied by the Exposition of 1867.

LAWN PAVILION.

MESSRS. BARNARD, BISHOP & BARNARD, of Norwich, England, have a very handsome lawn pavilion of iron, in the Main Exhibition Building. It is thirty-five feet long, eighteen feet wide, and thirty-five feet high, and is intended for use upon a lawn or ornamental grounds. It is after the Japanese style of architecture, with two floors—the lower approached by two or three steps, and the upper supported upon twenty-eight light square iron columns, with a verandah. The whole is surmounted by an ornamental zinc roof. Extending around the building is a wrought-iron railing, 4½ feet high, divided into seventy-two panels, in each of which is a sunflower eleven inches in diameter.

The columns supporting the upper floor are elaborately ornamented, and are connected by a transom bar 7 feet 6 inches from the ground. Secured to these columns are the brackets which support the verandah, and which are handsome specimens of iron-work. On either side of each of these brackets is a complete picture in cast-iron, given with great accuracy of detail.

The brackets also support the gutter and cresting of the lower roof. The cresting forms a wavy line which is surmounted at intervals by fans richly carved in imitation of flowers. Between the transom and the gutter are richly carved open-work panels, in which are medallions of various designs. The balcony-railing is light and graceful, and the ornamentation pendent from the balcony resembles lace-work, so delicate is the execution.

The upper roof is supported by twenty columns, similar to those supporting the second story. These are connected by a transom, far above which is open-work panelling. The brackets supporting the roof are different in design from those supporting the second story, and the spandrels are filled with many designs of a bolder character. The ceiling of the upper and lower compartments is composed of cast-iron panels in bas-relief, and the upper floor is reached by an ornamental staircase in cast-iron. The ceiling and upper portion of the walls of the interior will be covered by a silken cloth, richly embroidered. The designs for the pavilion were prepared by Mr. Thomas Jecky, of London.

ACADEMY OF NATURAL SCIENCES, PHILADELPHIA, PA.

THE library and museum of the Academy of Natural Sciences are now arranged in the recently constructed wing of the new building, and the institution has been lately opened. The portion of the building now finished has a front of 186 ft. on Race, by 75 ft. on Nineteenth street. The walls are of brick, faced on the exterior with green serpentine stone. The architecture is of the style known as the Collegiate Gothic.

The library and rooms for the botanical and entomological collections are on the first floor. The library is 130 ft. long and 30 ft. wide between the fronts of the book-cases, and is surrounded by a gallery 10 ft. above the main floor. Beneath this gallery, which is 15 ft. wide, are 4 small rooms on the south, 5 on the north, and 2 at the west end, designed for the use of committees and students, and one for the librarian. It is estimated that the room will properly accommodate 30,000, and leave floor space sufficient to seat comfortably 400 persons.

The second or museum floor is 180 ft. long by 60 ft. wide. The first gallery, 10 ft. above the main floor, is 21 ft. wide, and the second, which is 9 ft. above, is 18 ft. wide. The aggregate of floor space in the museum is 27,275 square ft., all of which is fully occupied by the collections. The room is, in all parts, well lighted. A lantern skylight, 80 ft. long, admits light to the nave, and windows on the sides and ends of the building light the galleries.

The plan of the entire building includes a south wing, covering an area of 139 ft. on Cherry street, and 75 ft. on Nineteenth street, with a central or main building of the same area set equidistant between the north and south wings, the three parallelograms being connected so as to show a uniform front on Nineteenth street of 288 feet.

In the new building the collections are placed in cases on the main floor and on the galleries of the second story of the building. The main floor is occupied chiefly by the collection of fossils, of fishes, mammals, osteology; the first, or Wilson gallery, by the birds, and the second, or Tryan gallery, by the conchological collections. The classification and arrangement of the collections are not yet completed. The cabinet of minerals is arranged in horizontal or table cases placed on the margins of both galleries. It contains about 6000 selected specimens. A collection of about 700 specimens of rocks, in table cases, on the main floor, represents the department of geology.

A recent revision of the library shows that it contains 22,440 bound and 621 unbound volumes, and 1255 pamphlets estimated at 125 volumes, making 23,186 volumes, to which are to be added 1238 bound and 127 unbound volumes belonging to the Entomological Section, making a total of 24,551 volumes, exclusive of 944 duplicate volumes.

FRENCH ACADEMY OF SCIENCES.—MARCH.

New Experiments on the Schistosity of Rocks and on the Deformation of Fossils correlative to this Phenomenon. By M. Daubrée.—The planes of division or of cleavage which characterize schistose rocks, and to which corresponds the property of division into thin leaves, as do the slates, are quite distinct from planes of stratification. A fundamental fact proves this, namely, the regularity with which the cleavage planes remain parallel, even when the beds which they traverse are greatly contorted. This shows that the cleavage planes are produced, not only after the strata in which they exist have been deposited, but even after these strata have lost their horizontal position.

The question of cleavage enters, therefore, intimately into the history of a large variety of rocks, and as the phenomenon has been attributed to mechanical action, masses of clay have already, by investigators, been submitted to immense pressure, with a view to producing a like condition by artificial means, and noting the accompanying characteristics. M. Daubrée's recent experiments in this direction were conducted by the aid of a hydraulic press, capable of giving a pressure of 220,000 pounds on the clay plates used.

The author communicates some of the results obtained, as follows:

Heretofore, the schistose texture of rocks has not been imitated artificially, but by means of a pressure exercised perpendicularly to the plane of schistosity. In the present experiments, leaves are produced in bands several metres in length in the same direction as the pressure and the movement. In this movement, the neighboring molecules do not travel uniformly. The different velocities which adjacent molecules thus acquire cause them to slide one upon the other. Hence a marked alignment of elements of differing forms, crystals, flattened lamellæ or microscopic particles. A very short motion of but a few centimetres suffices for the particles to become aligned, and a very regular leaf structure to manifest itself. Movements relatively very slow appear to produce this result, as well as movements relatively rapid. Microscopic examination of the masses in which artificial cleavage is produced, contributes toward their assimilation with rocks naturally in that state. Very thin sections cut perpendicularly to the leaves, either after simple drying at ordinary temperature, or after calcination at red heat, show their leaves of various hues, and which dispose themselves exactly around quartz grains, in the same manner as occurs to mica schists for the leaves of mica which envelop the granite particles.

Another resemblance of these products of experiment to natural productions, is found in their conductibility of heat.

On the Velocity of Heat Currents in bars of Wrought-Iron. By M. C. Dechanne.—By placing thermometers on a bar of iron this investigator finds that the cooling of the metal is slower than the heating. He has also determined the law that the times which a thermic current takes to reach different points of a bar are directly proportional to the squares of the distances of said points from the heated extremity; the velocities of the thermic current are inversely proportional to the squares of the distances.

Photo-micrographic Researches on the Transformation of Collodion in Photographic Operations. By M. J. Girard.—By photo-micrographic examination under a magnifying power of $\frac{4}{1}^{0}$, it appears that old collodion, which still gives fine images, but of which the rapidity is not as it should be, contains liquid bubbles of altered ether. If it was too alcoholic, it will have the appearance of a cellular tissue, and if it contained water the fibres of cotton will become apparent in the shape of amorphous flakes.

Too thick collodion, which is intense, but lacking in rapidity of impression, resembles a cellulo-vascular undulated tissue. This defect in regularity in the film is injurious to the clearness of the image which it receives.

On Communication by means of Water-Courses. By M. Bourbonze.—The author states that when the two extremities of galvanometer wires were placed in contact, the one with a gas-pipe, the other with a water-pipe of his laboratory, the existence of energetic electric currents is easily noted in the circuit so formed. Analogous results are obtained by placing one wire in contact with any stream of water, and the other with a piece of metal buried in the earth, or one wire in a well, and the other connected with the earth.

M. Bourbonze states that the result of all his experiments shows that telegraphic communication may thus be maintained without wires, over distances more or less considerable. Telluric currents may be substituted for those of the batteries ordinarily employed, provided that the immersed surfaces be varied. These currents are sufficient to decompose solutions of the metallic salts.

[Academy.]

SCIENCE NOTES.

PHYSICS.

Replacement of Metals in a Voltaic Cell.—In a paper read before the Royal Society (*Proceedings*, xxiv. 29) Dr. Gladstone and Mr. Tribe have drawn attention to the chemical reactions which take place in a simple voltaic cell, and their bearing on the chemical theory of the cell. A more positive metal displaces a more negative metal from its combinations. Of those metals with which we are acquainted potassium acts most powerfully in this respect, and we should therefore scarcely expect that any other metal could directly replace potassium. Now, in a simple voltaic cell, in which zinc is combined with platinum in dilute hydrochloric acid, the more powerful or electro-positive metal, zinc, displays the hydrogen which is in combination with chlorine, and the hydrogen makes its appearance against the less powerful or electro-positive platinum. The chemical theory of galvanism supposes that the force originates in the chemical action which takes place between the zinc and the acid; the contact theory supposes that it originates, in some unexplained manner, in the opposite electrical conditions of the two metals induced by their contact. If the chemical theory be the true one, it is evident that a zinc-platinum cell can only become active when the binary liquid contains hydrogen or some metal which is less powerful than zinc. If, for example, we were to employ a potassium salt instead of a hydrogen compound, on the chemical theory no action could take place. Such an action, however, does take place. If an aqueous solution of chloride of potassium be substituted for the hydrochloric acid, the zinc combines with the chlorine and the potassium is set free, in some form, against the platinum. The action is slow; but if magnesium be used instead of zinc, it takes place with sufficient rapidity to be easily observed. Instances are not wanting of the decomposition of one of its own salts by a metal in conjunction with another more electro-negative than itself; for example, magnesium connected with platinum will decompose a magnesium salt.

The Internal Constitution of Magnets.—A further communication from M. Jamin on the penetration of magnetism into steel magnets of various composition is given in the *Comptes Rendus* (tom lxxxii. p. 19). M. Jamin's object in making this last research was to confirm and give precision to his former statements respecting the superficial nature of the magnetism in a hard steel bar when magnetized to saturation, statements in direct opposition to those of MM. Trève and Durassier, which were published in the *Comptes Rendus* and noticed in the *Academy*. M. Jamin has had prepared for him a series of steel bars, containing increasing proportions of carbon; those most highly carbonized were very hard, were soluble only in *aqua regia*, feebly attracted by an electro-magnet, and feebly magnetized when placed in a coil traversed by a strong current. The results are given of experiments on one such bar 280mm long, 50mm broad, and 10.6mm thick. They show, beyond the shadow of a doubt, that for such highly carbonized bars the magnetism resides chiefly on the exterior, disappearing rapidly when the bar is submitted to the action of *aqua regia*. Three fourths of the imparted magnetism was found to be comprised in a layer 1.1mm in thickness, which enveloped a core 8.4mm thick, containing the remaining one fourth of the total magnetism. MM. Trève and Durassier had found, adopting the same method of solution, that the magnetism penetrated through the entire mass; a result which, the author of this paper points out, was to be expected, since the commercial steel which was employed is not nearly so highly carbonized as that of M. Jamin, and is a much better conductor of magnetism.

M. Jamin finds that the residual magnetism of the core is a function of the rate at which the solution takes place, of the length of the bar, and a number of other disturbing causes.

Action of Heat on Magnetization.—We have another paper on magnetism in the same record (tom. lxxxii. p. 276), by M. L. Favé. This paper is concerned with the loss of magnetism experienced by a magnetic bar when its temperature changes. It is known that the magnetic intensity of a magnet diminishes as the temperature rises, and it has lately been shown (by Jamin) that steel is susceptible of a considerable magnetization at a temperature at which it loses almost entirely the magnetism which it received when cold. M. Favé has shown (1) that the magnetic intensity of a body remains constant at any temperature, provided that temperature remains constant; (2) that the magnetism diminishes when the temperature changes (whether rising or falling), the diminution being at first slow, but more rapid after a certain time, which depends upon the temperature of magnetization; (3) the quantity of residual magnetism after cooling increases again when the magnet is heated afresh.

PHYSIOLOGY.

Nitrogen from the Living Body.—It has been laid down as a law by Pettenkofer and Voit, that all the nitrogen derived from the decomposition of azotized substances in the system is eliminated through the kidneys and the alimentary canal. It follows of necessity that no uncombined nitrogen can be got rid of through the lungs. This necessary inference, however, is opposed to the results of direct observation; for Regnault and Reiset succeeded in demonstrating the presence of an appreciable excess of uncombined nitrogen in the expired air. Dogs, cats, and fowls were kept in an air-tight chamber, under suitable conditions as regards food, air, etc., for periods of time varying from twenty-four to forty-eight hours; and a decided excess of gaseous nitrogen was found to be present in all cases at the conclusion of the experiment. The excess was not, of course, great; but it was quite sufficient to prove that nitrogen is eliminated from the living body in an uncombined state.

On some Effects produced by Lowering the Temperature of the Body in Warm-Blooded Animals.—Horvath furnishes a summary account of a long series of investigations on this subject to *Pflüger's Archiv.* He finds that when a warm-blooded animal is cooled down by immersion in water at 0° C., death occurs with tetanic symptoms when the temperature of the body sinks to 19° C. If artificial respiration be kept up, however, the animal is able to survive the reduction of its temperature to a much lower point than this. The minimum limit, indeed, can not be determined absolutely; it varies with the age, species, and constitution of the individual subject. Puppies, for example, may be cooled down to 5° C. with impunity, even when artificial respiration is not employed. During the cooling process the arterial blood-pressure gradually sinks to zero, and the heart beats more and more slowly. After death the systemic veins are found gorged with blood and the liver enormously congested. Both striped and unstriped muscles are paralyzed; but the former resist the paralyzing influence of extreme cold for a longer period than the latter. Electrical stimulation of the brain becomes less and less effectual in provoking movement as the temperature sinks. The fatal issue is immediately due, in a considerable proportion of the cases, to asphyxia. The muscles of respiration appear to be paralyzed in consequence of the curare-like action of extreme cold upon the end-organs of their motor nerves; hence the value of artificial respiration for maintaining life. In other cases, again, death seems to result from coagulation of the blood in the vessels, a phenomenon whose connection with refrigeration is not obvious. But asphyxia and thrombosis do not exhaust the possible efficient causes of death; there are others in operation, whose nature has not yet been exactly ascertained.

On the Capillary Circulation in the Muscular Walls of the Heart.—It is usually assumed, in conformity with Brücke's views, that the capillaries which supply the muscular tissue of the heart with blood are emptied during the ventricular systole. The evidence for this belief has hitherto been of an indirect kind only; but Klug has recently endeavored to furnish experimental proof in its support (*Centralblatt für die Med. Wiss.*) The heart of the rabbit was arrested at the close of its systole, and at the close of its diastole, by instantaneous ligature of the great vascular trunks proceeding from it. The organ was immediately removed from the body, and plunged into alcohol; after its tissues were thoroughly hardened,

transverse sections of the ventricular wall were subjected to microscopical examination. It was found that the capillary vessels in the expanded ventricle were loaded with blood, especially in the neighborhood of the heart's apex; while in the contracted organ the capillaries of the corresponding region were collapsed and bloodless.

Researches on Reflex Vasomotor Stimulation.—Latschenberger and Deahna publish the results of a protracted investigation into the effects of the division and continued stimulation of various afferent nerves upon the arterial blood-pressure (*Pflüger's Archiv.*). These effects are of a very complicated kind; but their analysis has led the authors to certain important conclusions, of which the following is a very condensed summary. From every vascular area throughout the body, centripetal fibres of two kinds proceed to the cerebrospinal axis. Stimulation of one set of these fibres is followed by contraction of the arterioles all over the body and a rise of blood-pressure; while stimulation of the other set causes general dilatation of the arterioles, and a fall of blood-pressure. The former may be termed elevator, the latter depressor fibres. When the two are stimulated together, the elevator fibres are always the first to become exhausted. In the normal state, centripetal impulses are continually being transmitted along both sets of fibres, and the degree of arterial blood-pressure at any moment must depend, *cateris paribus*, upon their mutual interference. An increase of tension in any vascular area stimulates the corresponding depressor fibres, and is instantly followed by a reflex fall of the general arterial pressure; while any local decrease of tension produces an exactly opposite effect by stimulating the elevator fibres. Hence the peripheral vessels must be regarded as in some degree capable of regulating the blood-pressure in their own interior. The hypothesis of automatic vasomotor centres in the cerebro-spinal axis, though not proved to be erroneous, becomes superfluous; for the self-regulating reflex mechanism is amply sufficient to explain all those variations of arterial tension which are represented in the kymographic tracing by curves of the third order (Traube's waves).

On the Nature and Function of the Succus Pyloricus.—The tubular follicles situated in the pyloric part of the stomach are believed by the majority of physiologists (Köliker, Donders, Schiff) to secrete mucus only, and to take no part in the production of pepsin. Heidenhain and his pupils, on the other hand, have been led, by observing the morphological resemblance between the cells lining the coecal ends of the pyloric tubes and the adelomorphous cells of the true peptic glands, to attribute peptic properties to the former as well as to the latter. Numerous experiments have been performed to decide the point; but these experiments, though all of one kind (artificial digestion with portions of mucous membrane excised from the pyloric region and the fundus of the stomach respectively), have hitherto furnished incompatible results. In order to arrive at a definitive solution of the problem, Klemensiewicz has attempted to obtain pure pyloric juice, unmixed with the secretion of the fundus, from the living animal (*Wiener Akad. Sitzungsber*). He employed a modification of Thiry's procedure, and succeeded in collecting a sufficient amount of material for examination. The *succus pyloricus*, procured in this way, is a viscid liquid, translucent and colorless, in thin layers; it is distinctly though feebly alkaline, and though incapable, *per se*, of dissolving albumen, it is found to possess a high degree of solvent power when mixed with a sufficient amount of dilute hydrochloric acid. This proves that it contains pepsin, and comparative trials led to the conclusion that it is actually richer in this ingredient than the acid secretion of the fundus. Moreover, it is able to dissolve gelatin, and to convert starch into sugar; but it produces no appreciable effect on fatty matters.

ON THE PREPARATION OF DEXTRINE-MALTOSE (MALT SUGAR) AND ITS USE IN BREWING.

By WM. GEO. VALENTINE, F.C.S.,

Royal College of Chemistry, South Kensington.

[A paper read before the Chemical Section of the Society of Arts, London, March 17th, 1876, Prof. Williamson, F.R.S., in the Chair.]

(Continued from page 299.)

CHANGES PRODUCED IN MALT DURING MASHING.

WHEN ground malt is submitted to the mashing process, certain of the albuminoid bodies contained in the malt act upon the starch, and the latter is dissolved, with what changes will be shown more fully farther on. The other carbohydrates, the constitution of which is as yet not fully made out, go likewise into solution. The albuminoids soluble below the mashing heat (say 68 C.) are also dissolved, and the insoluble constituents of the malt remain in the grains. The wort, therefore, contains the transformation products of the starch—principally Dextrine-Maltose—of the other carbohydrates, the soluble albuminoids, the soluble portion of the ash, and a little soluble fat.

Boiling with hops removes a portion of the albuminoids. Some of the carbohydrates, other than the starch products, undergo a slight change, which has not yet been thoroughly examined; but the starch-products are but slightly altered, in what way will be shown hereafter.

FERMENTATION OF THE WORT.

When the boiled hopped wort is subsequently submitted to the action of yeast, the carbohydrates other than those derived from starch yield alcohol first, and the portion thereof which is fermentable (60 to 70 per cent) disappears almost altogether in the very earliest stages of the fermentation; the growth of the yeast removes a portion of the albuminoids left, and some (a very small quantity) also of the sugar, and there remains then in the beer, when the first stage of the fermentation is over, and when it is fit to go into the casks, the alcohol and a portion of the carbonic acid derived from the carbohydrates other than starch, and also from a portion of the products of the transformation of the starch itself effected by the ferments (which, as I shall have conclusive evidence to adduce, consist of dextrine and maltose). Hence it is found that the whole of the dextrine, a considerable portion of the maltose, the remainder of the albuminoids, the soluble matter of the hop, and a few other constituents upon which I need not touch further, are left for after-fermentation.

In order to correctly understand the part which the dextrine and maltose play in the after-history of a beer, we will examine for a moment the constitution of a typical Burton pale ale, analyzed when the principal fermentation was finished.

That the constitution of ales will vary within certain limits, even when brewed in the same town, and by processes which vary only within narrow limits, will be readily admitted. Nor does it matter, as long as I can show you by a carefully-conducted analysis of a representative sample of pale ale, what the changes are which fermentation effects.

A normal sample of pale ale, showing an original gravity of 1063, gave, when finished and ready to be put into casks, a distillate of sp. gr. .992, equal to 33.7 degrees of gravity lost.

33.7 degrees of gravity lost.	
1029.39 residue.	
1063.09 original gravity.	

The unboiled wort of this beer, supposing it to have been brewed from No. 1 malt and reduced to the above specific gravity—namely, 1063—by allowing for concentration on boiling (in order not to unnecessarily complicate the explanations which I will endeavor to give of the changes) would contain in every 100 parts by measure the following solid constituents:

Maltose	6.66
Dextrine	3.44
Other carbohydrates, fermentable	3.30
Ditto, unfermentable	1.48
Albuminoids	1.45
Ash, phosphates, sulphates, etc.	0.17
Total	16.50

After boiling with hop (and correction for loss by evaporation, so as to keep it at the normal original gravity of 1063), it was composed as follows:

	Solids in 100 parts.
Maltose	6.66
Dextrine	3.44
Other carbohydrates, fermentable	3.80
Ditto, unfermentable	1.00
Albuminoids	1.05
Hop extract	.33
Ash	.27
	16.55

Hence it follows that the fermentable constituents of the hopped wort have undergone but little change.

Not so, however, when the principal fermentation with yeast is finished and the ale is ready to be put into the cask, for the beer contains now:

	Alcohol and solids in 100 parts.
Alcohol	4.48* sp. gr. .992
Maltose	1.52
Dextrine	3.44
Carbohydrates, fermentable	trace
Ditto, unfermentable	1.90
Albuminoids	.66
Hop extract	.33
Non-volatile products of the fermentation	.47
Ash	.24
	7.66

Maltose and dextrine, constituting, however, by far the greater part of the remaining solids—namely, very nearly 60 per cent.

It will now become clear of what importance maltose and dextrine are to the brewer, both during the fermentation process, and during the after history of the beer, that is, for insuring keeping powers. How is it, then, you will ask, that only recently mention has been made of this body called maltose, so important to the brewer? This I will endeavor to answer as clearly as possible, so as to leave no doubt in the minds of any one present here to-night. We may perhaps then be spared in future the humiliating feeling that chemists should still be found who call a sugar "glucose," when in reality it is, as has been amply shown to all who will listen and experiment, a sugar of widely different properties; that it is, in fact, what chemists in France (Dubrunfaut), in England (O'Sullivan), and in Germany (Schulze) have shown us most conclusively, and all but independently of each other—namely, maltose. This name was given to it by the first observer (Dubrunfaut), and retained by O'Sullivan, who undoubtedly has the merit of having placed this new sugar, found in malt-wort, beyond a shadow of a doubt, and of having pointed out its character, composition, and affinities.

The sweet taste of malt led for a long time to the supposition that the starch of the grain was converted into sugar during the malting process. A very superficial examination, however, will show this, in the main, to be erroneous. Starch can be isolated from the malt as well as from barley. Starch, then, it was found, was converted into sugar only during the process of mashing, presumedly by the action of an albuminoid body, called "diastase," supposed to be produced during the malting process. This, too, is not altogether a correct notion, for barley contains sufficient of the transforming or saccharifying agent to dissolve the whole of its starch.

The action of this transforming agent on starch has been the subject of much investigation. Little or no attention was paid to the properties of the transformation products.

The portion thereof which reduced cupric oxide was put down as glucose, grape-sugar, or dextrose, and the remainder as dextrine, and even on this supposition there has been a great diversity of opinion as to the proportion of these substances produced. It is mainly owing to O'Sullivan's painstaking and admirable labors that we have obtained a clear and definite knowledge of the exact properties and composition of the transformation products of the starch of malt, and that the quantity of each can now be determined with any degree of accuracy. After the successful isolation of the sugar maltose found among the transformation products in wort, the relative proportions of these two bodies produced, when starch is dissolved by malt-extract, had yet to be determined, and the thought of giving a practical application to the new discovery was but a natural consequence.

If we examine for a moment the malt analyses given above, and suppose that during the mashing process the malt yielded an extract of 74 per cent, we perceive that the starch amounts to little more than 59.6 per cent.; the maltose and dextrine in the wort to a little more than 61 per cent of the extract, the increase being due to the binding of water. This very closely corresponds to the theoretical per centage of these bodies, obtainable, if starch splits up, according to the equation:

$$\underbrace{C_{18}H_{30}O_{15}}_{\text{Starch.}} + OH_2 = \underbrace{C_{12}H_{22}O_{11}}_{\text{Maltose.}} + \underbrace{C_6H_{10}O_5}_{\text{Dextrine.}}$$

that is 32.15 per cent of dextrine and 67.85 of maltose.

When starch-paste was submitted to the action of malt-extract, it dissolved, and the solution, at the end of an hour or two hours' digestion, contained of solid matter (allowing for the malt-extract employed) 67.85 per cent of maltose and 32.15 per cent of dextrine. Hence the starch split up under the influence of malt-extract according to the equation given above. This is the normal transformation, and it is the one obtained in well-managed washing operations. Other proportions of maltose and dextrine are obtainable, and this is one of the reasons why brewers sometimes find, although they use the same quantity of yeast, that the attenuations are sometimes too low and sometimes too high. When this occurs they change the quantity of yeast, which is all well enough in its way, but few of them, as far as I know, go to the real root of the evil—namely, the different proportions of maltose and dextrine formed in the mashing process. If the composition of the boiled wort given in the diagram be examined, it will be found that about 64 per cent is fermentable matter. In all well-conducted brewing operations, at the time of racking the beer, if the original gravity be determined, few instances will occur in which the amount of matter fermented is more than 64 per cent of the original solid matter before fermentation. There may be cases in which this number is exceeded, as in old beers, in which the after-fermentation had taken place, or badly brewed beers, in which proper attention had not been paid to the mashing operation. Every brewer present will also know that it sometimes happens that the beer can not be attenuated low enough, that, in fact, not more than 50 per cent of the solid matter in the extract can be fermented. The blame is then laid to the barm or the water, and it is never imagined that is due to the too high proportion of dextrine obtained from the starch in the mashing process. It is pretty well understood that if a pale ale, the worts of which had, say, a specific gravity of 1063–1064, can be got into the cask, when it is reduced by fermentation down to 1020–1021, things are going on rightly. The meaning of this is not far to seek. The wort would contain in every 100 parts, by measure, 16.5 parts by weight, or thereabouts, of solid matter of the composition already referred to. The specific gravity of the finished beer being taken at 1021, the specific gravity of the spirit contained in the finished beer would be 992, or 8 less than 1000. The specific gravity of the finished beer taken at 1021, the specific gravity of the beer, without the alcohol would amount to 1029 (1021 + 8). This represents 7.6 per 100 of solid matter, or 16.5 — 7.6 = 8.9 of converted matter, and when expressed in per centage numbers = 53.9, say 54 per cent, thus leaving still in the beer, as shown above, about 10 per cent (on original extract) of fermentable matter. This matter is maltose, and it serves to keep up, by its slow and gradual fermentation, the condition of the beer in cask. Beer, in common with all fermented liquids, is always slightly acid; and this acid fluid, no doubt, converts a further portion of the non-fermentable carbohydrates into fermentable ones, and hence a portion of the dextrine into maltose, and finally into alcohol. This, in well-brewed and finished beers, is always a slow and gradual process.

(To be continued.)

* That is, slightly less than 50 per cent on the solid matter fermented.

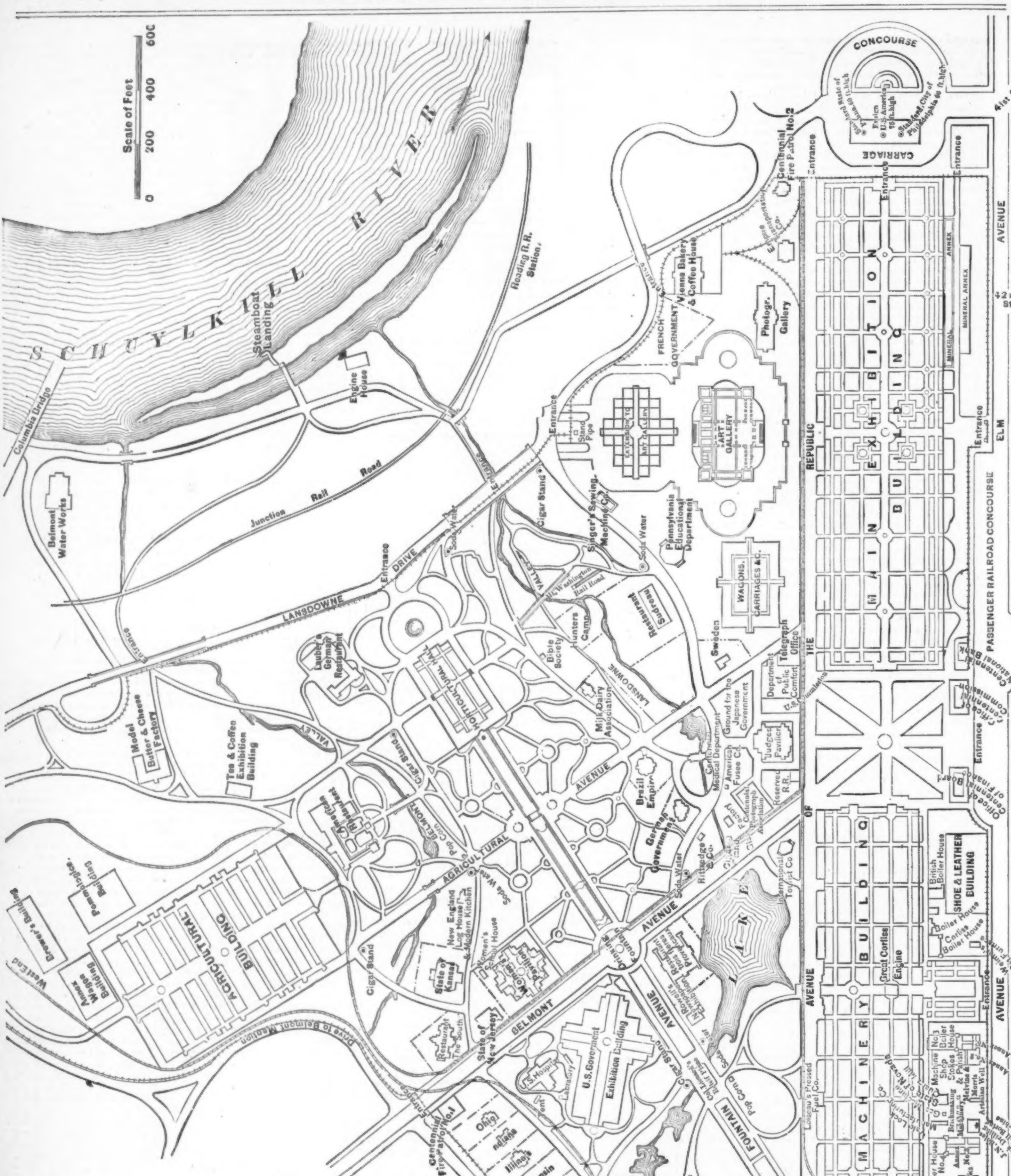
[Mining Journal.]

THE MECHANICAL VENTILATION OF MINES.

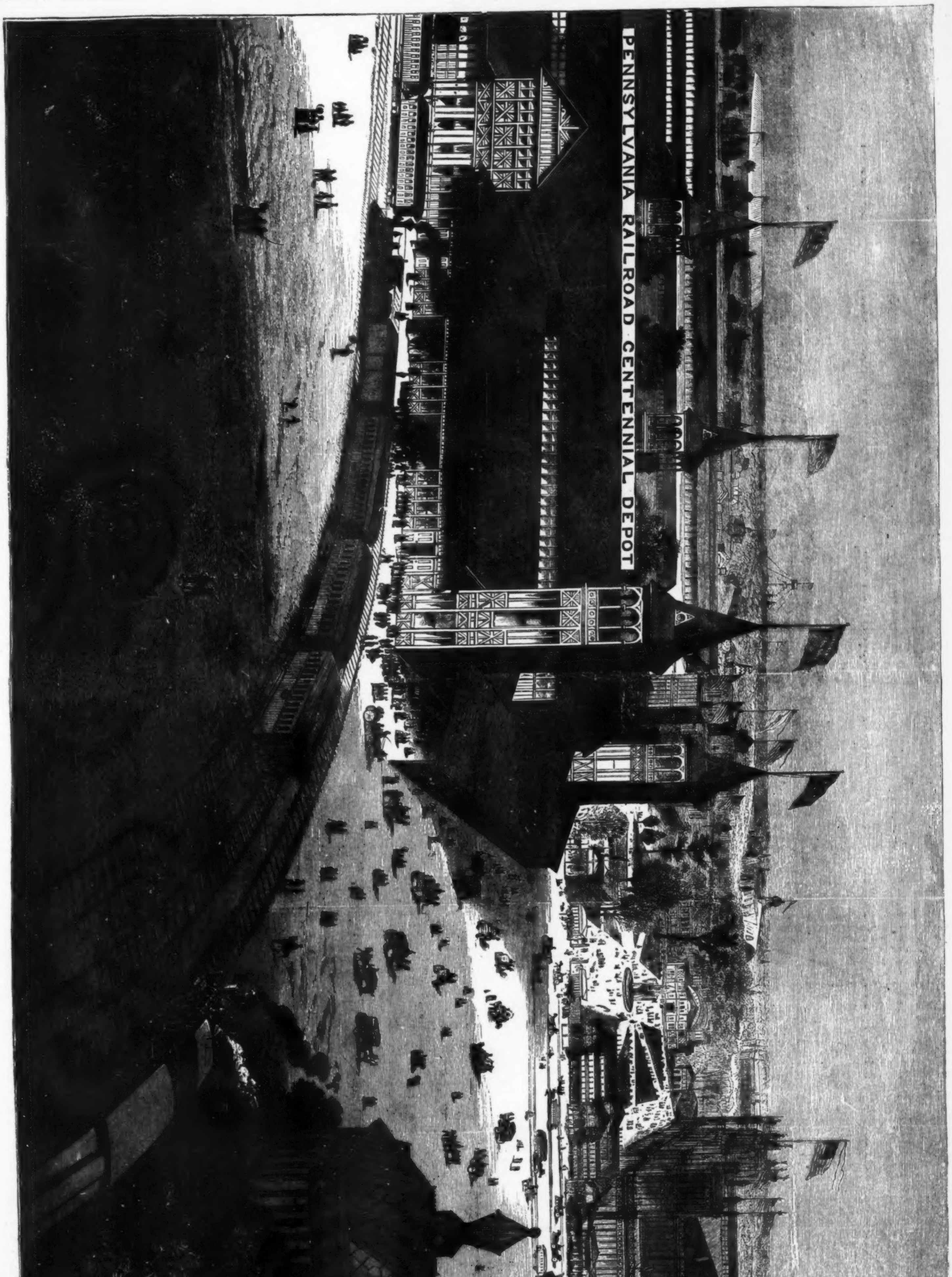
AT the present time more than ordinary attention is being directed to the best means of ventilating mines, more particularly those where a large quantity of gas is constantly produced. The atmospheric air sent through a colliery undergoes in its passage certain modifications which render it unable to keep the workings clear of gas. The respiration of men and animals gives birth to extremely deleterious gases. Sulphides become sulphates, carbonates turn into peroxides, whilst vegetable and other matter undergoes fermentation in which the oxygen disappears and gives way to carbonic acid, carburetted hydrogen, nitrogen, and ammonia. For the safe working of many of our mines it is, therefore, essential that there should be a large and constant supply of fresh air sent from the surface so as to permeate every part of the workings. To effect this, various systems have been in operation, including the furnace, fans, steam-jets, screws, etc. The furnace has long been the means of ventilating most of the collieries in every part of the kingdom. The amount of air produced by a well-constructed furnace variesfrom 4000 to 8000 or 9000 cubic feet per minute for each foot in breadth of the bars. Still the temperature of furnaces is very variable, and to some extent also isthe ventilation, whilst there is considerable danger in the return air containing the gas being carried over the furnace instead of through a dumb-drift into the shaft. The furnace is also a source of danger from other causes, for it is little more than three years ago since the slack for feeding the furnaces ignited at Darfield Main, Barnsley, then set fire to the coal, and led to a loss to the proprietors of more than £60,000, and to the putting down of a powerful fan.

But mechanical ventilation, it may be said, is by no means a new system, although of late it has made very great progress, for we find the Duck machine was in use at the commencement of the present century in Cornwall. Mr. Struvé, of Swansea, made some important improvements with respect to aërometers. By covering them so as to make them double-acting, and placing the valves at the side, he succeeded in producing a machine far superior to any that had preceded it. Some twenty years ago a couple of such machines were put down at the Middle Duffryn Colliery, in South Wales, at a cost of about £1000. They were 20 feet in diameter, and were capable of exhausting 80,000 cubic feet of air per minute. At one of the Earl Fitzwilliam's collieries, at Elsecar, there is a large fan that has been working most successfully. It was put down by Mr. Biram, the well-known inventor, and, we believe, has been constantly at work up to the present time. Of late years, however, the superiority of the fan has been clearly demonstrated by Mr. Morrison, of Newcastle, the agent for the Guibal, which deservedly takes the highest rank, many of them being now in operation in different parts of the kingdom. The Schiele fan—an economical one, taking up comparatively little room, and not requiring extensive and expensive masonry—has made marked progress of late, one of them having just been put down at Corton Wood Colliery, near Barnsley, where the shafts are twenty feet clear in diameter. Another fan which has been put down in many places is that known as the Leeds fan, manufactured by Messrs. Easton & Tattershall, of the Alexandria Foundry, Leeds. We believe it was first tested at the Darfield Main Colliery, where we have seen it at work, when we found that with $5\frac{1}{10}$ water-guage it gave 66 revolutions per minute. It is now being worked at several collieries in the West Riding with great success.

Ventilation by means of the steam-jet was attempted to be revived some few years since, but it failed. At the Tyne Main Colliery at one time 61 jets, each $\frac{3}{16}$ of an inch in diameter—united area, 1.68 square inch—were placed in cylinders 6 feet long and 11 inches in diameter, with two boilers 30 feet long and 6 feet in diameter. The latter consumed 20.48 pounds of coal per minute, and evaporated 109 cubic feet of water per minute. The amount of ventilation given was 49,500 cubic feet per minute. All things considered, without giving any opinion as to the relative value of the various fans, we believe that system is sure to supersede the furnace in all our large collieries, particularly those that give off much gas.



THE INTERNATIONAL EXHIBITION OF 1876.
GENERAL PLAN OF GROUNDS AND BUILDINGS.



THE INTERNATIONAL EXHIBITION OF 1876.—RAILWAY-STATION AND MAIN ENTRANCE.—Principal Exhibition Building at the right.—(*See page 337.*)

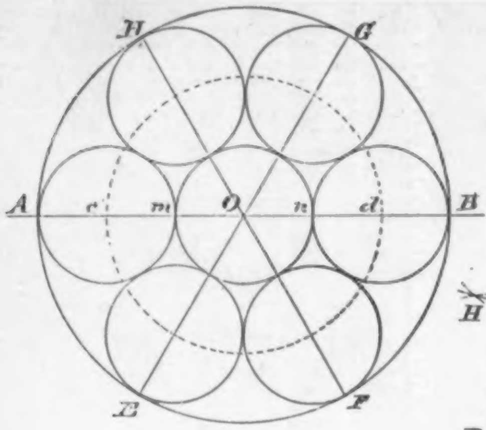


Fig. 110.

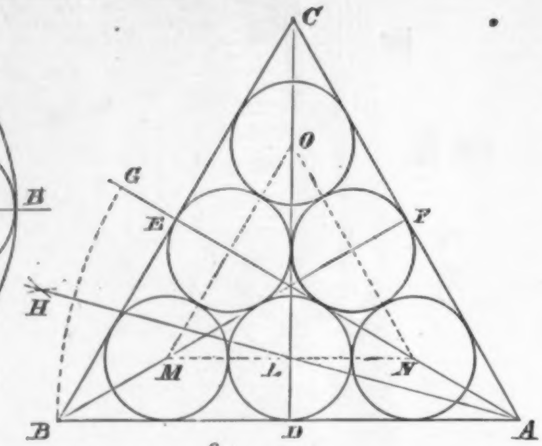


Fig. 111.

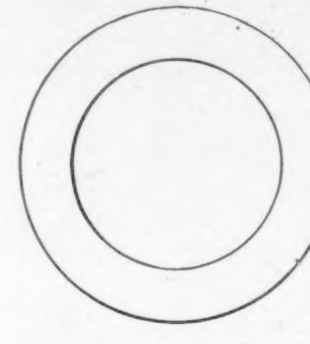


Fig. 113.

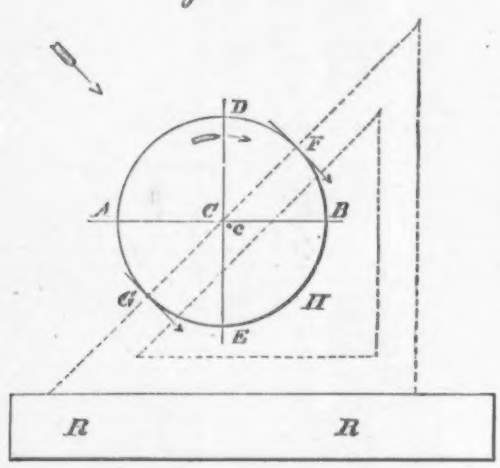


Fig. 112.

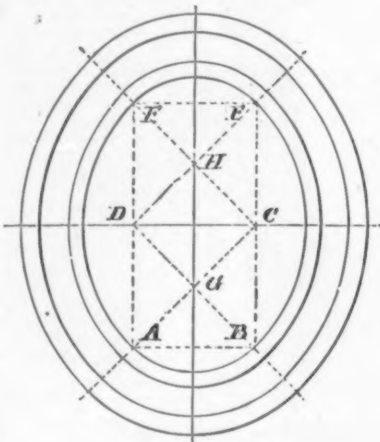


Fig. 114.

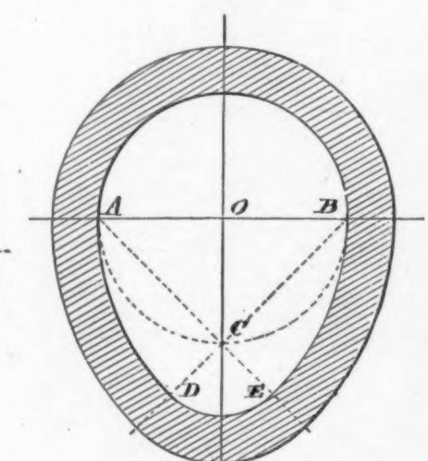


Fig. 115.

LESSONS IN MECHANICAL DRAWING.

LESSONS IN MECHANICAL DRAWING.

By Prof. MacCord, Stevens Institute.

(Continued from page 310.)

No. XI.

In continuation of the line of practice mentioned in the last lesson, we give two diagrams similar in character to Figs. 104 and 105; but in Fig. 110 we have six circles instead of three to inscribe in the circle, with the additional requirement that they shall be tangent to a central circle, as well as to the given one and to each other. The construction is obvious on mere inspection; the diameter is to be divided into three equal parts (which may be done either by trial and error, or by the method of Fig. 33), and the points of division are also points of tangency. Thus the trisection of A B gives M, N, and O M is the radius of the central circle and of its two neighbors whose centres are C and D on the line A B.

It is best, in constructing this figure, to draw this line first, of indefinite length, then to select the centre O, describe the outer circle and at once to mark off with the same radius the distances A E, A H, B G and B F, and draw the diameters F H, G E, in order to ensure accuracy in the division of the circle.

In Fig. 111 it is required to inscribe in an equilateral triangle, six circles tangent to it and to each other. *Construction.* A G, perpendicular to B C, bisects the angle at A, and also bisects B C in E. Bisect the angle B A E, as indicated by the dotted arc B G, and the intersection H of arcs whose radii are equal, and whose centres are B and G. The bisecting line A H will cut C D, perpendicular to A B, in the point L, the centre of one of the required circles, whose radius is L D. Draw through L a parallel to A B; this will cut A H in M, and B F, perpendicular to A C, in N, which will be the centres of two of the other circles, and the remaining centres are found by completing the equilateral triangle M N O, the radii of all being equal.

The peculiar value of these diagrams as exercises for practice, lies in the fact that, notwithstanding their extreme simplicity of construction, each step so affects those which follow that the student is absolutely compelled, in order to arrive at a satisfactory result, to exercise the utmost care throughout; for an error in the location of a centre, or in the adjustment of the radius, of half the thickness of a reasonable pencil line, will make its existence painfully obvious. And it will be found that the habits presumed to be now formed of keeping the pencil trimmed to its keenest working edge, and of handling it lightly, and not as though the innocent paper were a criminal to be suppressed by the strong hand, have not been inculcated without some idea of what might happen through a neglect of these little things.

We come now to the consideration of the shadow line as applied to the circle. In Fig. 112 we have a representation of a circular disk of some sensible thickness, A B being the horizontal, D E the vertical centre line. Now supposing, as explained in Lesson III., that the light comes apparently in the direction of the arrow at the upper left-hand corner, but actually from behind the spectator, so as to shine downward toward the paper, it is obvious that the disk will cast a shadow toward the lower right hand corner of the figure, and that this shadow will begin at F, where the line parallel to the arrow touches the circle on one side, and end at G, where another parallel to the arrow touches it on the other. Since the radius is perpendicular to the tangent at its extremity, these points of tangency are readily found by drawing a diameter perpendicular to the direction of the light. It will now be seen that it is very convenient to suppose the light to have the direction shown; that is, making an angle of 45° with the vertical and horizontal lines, for if we place a ruler horizontally at R R, our triangle of 45°, as shown in dotted lines, enables us at once, by placing its edge so as to pass through the centre, to mark the points F and G without drawing a line.

Were we making a finished picture the shadow of the disk would be, or at least might be, drawn, and it would be bounded by part of a circle of the same diameter as the disk; also it would obviously be widest opposite the point H, midway between E and B. And in representing, or indicating the existence of, a shadow bounded, or rather cast, by the semicircle F H G, by making its outline heavy, this difference in breadth may also be indicated by making the shadow line heavier or thicker in that region where the shadow itself would be broadest, as is done in the figure.

This thick line, it will be observed, must be tapered off in such a way that at the points F and G it shall be no heavier than the rest of the outline, because the semi-circumference G A D F is illuminated and does not cast a shadow, and if the shadow line were not tapered there would be an unmeaning and unpleasant break in the outline of the disk.

This tapering of the line, by the use of a pen which is expressly adapted in its construction to the purpose of drawing a line of perfectly uniform thickness, is a matter of some little difficulty at first.

It is sometimes accomplished by setting the needle point of the compass in a new position, as *c*, very near the true centre of the disk, in the direction from it in which the shadow is to fall, striking a new circle, with the same radius as that of the disk, and filling in the space included between it and the original outline.

But though this is all correct in theory, it is not so easy in practice to do this as to talk about it. It will answer very well if we are making drawings on a very large scale, intended simply as illustrations, to be viewed from a considerable distance, as for instance, if they be intended to aid a lecturer in explaining the objects represented to an audience. In such drawings very minute accuracy is not aimed at, and all the lines not only may, but must be quite thick, in order to be clearly seen from the farthest part of the room, and the shadow lines therefore become in reality broad bands.

It may be remarked here, that when the most minute accuracy is imperative, as, for instance, in a diagram representing the movements of different parts of a piece of mechanism, so that measurements are to be taken from the lines, the latter must be made as fine as possible, and any thickening of the line in any part, for any purpose whatever, is wholly inadmissible.

And for the ordinary purposes of mechanical drawings, the shadow lines are intended only to give relief to objects nearer the spectator than others, or parts of the same object in different planes, and it is very easy to go to an extreme in their introduction. It is not, however, easy to give a definite and positive rule by which to determine how heavy they should be; but it may be stated that in shaded drawings, or finished pictures, it is necessary to make them comparatively heavier than in outline drawings, in which it is safe to say that it is rarely that they need be more than twice as heavy as the regular outline. Consequently, the method of putting them in, above explained, can not be employed; for the new position to which the needle-point would require to be moved would be so small that there would be great danger of its slipping back into its original position.

It is therefore necessary to vary the thickness of the line without shifting the centre. This may be done by a manipulation something like that explained in the preceding lesson in regard to the straight-line pen. The compass is to be set in motion before touching the pen to the paper, brought in contact with it very lightly, the pressure increasing as the motion proceeds, and again diminishing as the termination of the shadow line is approached, the pen being finally lifted off the paper while still in motion. This may be repeated more than once, with an arc of contact made less and less each time; the result being that, as shown in Fig. 112, the quadrant B E is of a thickness nearly or quite uniform, the graduation or tapering being confined to the half-quadrants B F and E G; which, though not rigidly correct in theory, if we regard the absolute thickness of the line as indicating or corresponding to the breadth of the shadow cast by the part of the object which it bounds, will be found to give a more satisfactory effect than if it be tapered in both directions from the point H.

But it is not essential to the theory of the shadow line that we should regard its thickness as varying with the breadth of the shadow: it may be considered as merely indicative of the fact that a shadow is cast, and then we are at liberty to modulate its thickness to suit circumstances, without being conscious of doing anything morally wrong.

In Fig. 113, we have represented a ring, of sensible thickness, merely for the purpose of showing, in an isolated drawing, the effect that should be aimed at, without having it confused by any extraneous lines: the shadow of the inner circle is, of course, cast by its concave part, and the points of tangency are determined by applying the triangle, as in the preceding figure.

It is necessary, in order to produce the best effects in drawing, that the operator should be able to manipulate the instruments in such a manner as to graduate these shadow lines so that it shall be impossible to tell precisely where the fine outline begins to be thickened. Perfect smoothness is essential; and it can be attained, and with perfect certainty, in the manner last described, if sufficient time and patience be bestowed upon the practice. Some find far more difficulty in acquiring the precise touch, which we have endeavored to explain as clearly as possible, than others; but it is within the reach of all who will persevere.

The limiting points are found in the case of any other curve precisely as they are in that of the circle—that is to say, by drawing a tangent parallel to the direction of the light. Now, the curve may be one whose mathematical creed is unknown, so that it is not possible to determine exactly the point of tangency. But this need not alarm a draughtsman; because, since the exact beginning of his shadow line *must* not be perceptible, the exact location of it need not be known. That is to say: although the eye alone can not decide the exact point of tangency between two lines, it can approximate closely enough to it for this particular purpose. In the case of the circle, it is just as easy to mark it exactly, as shown in Fig. 112, as it would be to guess at it; but it does not follow that it will be absolutely any better to do so. In fact, after a little practice, it will be found quite needless to make any construction, or to apply the triangle, at all, in the case of circular arcs, the eye being able at a glance to determine the limits of the shadow; but until considerable experience has been gained, it will be found more satisfactory to keep on the safe and sure side by marking the points, since an error is not easily repaired or corrected—it usually involves the erasure of the entire arc or circle, and this risk is wholly needless.

The necessity of having circles truly tangent when they ought to be, or claim to be, is nowhere more apparent than in the drawing of outlines which are made up of arcs of circles of different radii. And this has very often to be done, especially in mechanical subjects: for when such circular arcs will answer the purpose as well as other curves, it is better to use them, so that the mechanic who is to work from the drawing can readily lay them out with the tools always at hand. We give an example of this in Fig. 114. A B C D, C D E F, are two equal squares. Drawing first the diagonals in these squares, take C as a centre, and draw the arc A E, with radius C A; then

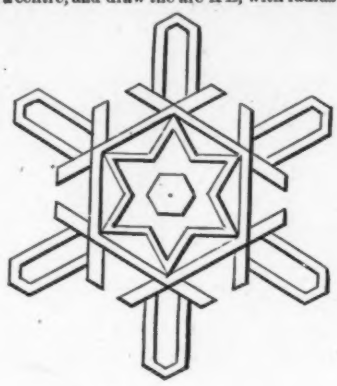


Fig. 116.

with D as a centre, and the same radius, draw the arc B F. Next about centre G, with radius G A, draw the arc A B, and about H describe the arc E F. The two arcs last drawn should be tangent to the other two, forming a closed figure, which has some resemblance to an ellipse; and this outline should appear perfectly smooth and continuous, without break or variation in thickness, the junctions of the different arcs of which it is made up being entirely imperceptible. And simple as the construction is, it will be found that the production of such a line requires considerable care and some skill: when it has been accomplished, but not before, the student may go on to surround it by others as shown, keeping the same cen-

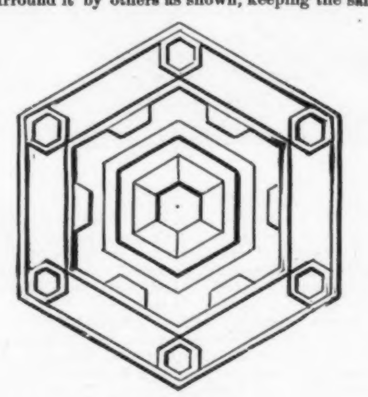


Fig. 117.

tres, C, D, G, H, but increasing the radii, producing the diagonals of the squares so as to determine the points of tangency. By adding the shadow lines, as in the figure, we have a drawing of a picture frame, such as sometimes miscalled oval, made of a broad band with two narrow raised mouldings of a square section. We say *miscalled* oval—this form more nearly approximates to the elliptical, and is, it will be noticed, composed of four precisely similar parts, being symmetrical as to both the vertical and the horizontal lines. In order to make the distinction clear, we have in Fig. 115 given a section of a form frequently given to sewer pipes—which is symmetrical about the vertical line, but not about the horizontal, being larger at one end than at the other, like an

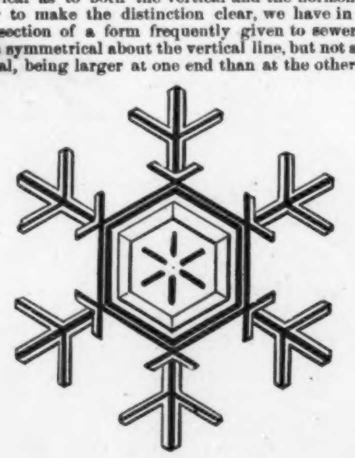


Fig. 118.

egg, whence the name *oval* is properly applied to this figure. About O, the intersection of the indefinite centre lines, describe a circle with any diameter A B, cutting the vertical centre line in C; draw A C, B C, and produce them: then about A, with radius A B, describe the arc B E, about B with the same radius describe A D, and with centre C and radius C D describe D E completing the oval. The external outline is drawn as in the preceding case,—that is to say, by describing arcs about the same centres with greater radii; the cross-lining, or *sectioning*, is then done, care being taken to have the lines finer than the outlines, so that the latter may be prominent, and the shadow lines put in at the very last. The remaining figures accompanying this lesson, being exercises for right-line work only, and drawn from the same source which has furnished several of the preceding ones, should require no explanation; as the student who has once familiarized himself with the principles involved in the construction of those, will find no difficulty in extending their application. And that extension is all that is involved in the drawing of these—they are more complex, fuller of detail, but that is all. Some of the first of these may have appeared exceedingly elementary—and so they were, and were selected with the definite purpose of pointing out the principles of construction—and yet, simple as they are, they will be found excellent practice, if they are drawn on a small scale—the perfection of their forms, and the beauty of the drawings, depend so largely on their symmetry, that the eye as well as the hand will be unconsciously trained in reference to that feature—a training too often neglected, and one which the draughtsman will find of great value.

ON REPULSION RESULTING FROM RADIATION.*

By WILLIAM CROOKES, F.R.S., etc.

IN this paper the author describes experiments on the repulsion produced by the different rays of the solar spectrum. The apparatus employed is the horizontal beam, suspended by a glass fibre and having square pieces of pith at each end coated with lampblack. The whole is fitted up and hermetically sealed in glass, and connected with an improved mercury pump. In front of the square of pith at one end a quartz window is cemented on to the apparatus, and the movements of the beam, when radiation falls on the pith, are observed by a reflected ray of light on a millimetre scale. The apparatus was fitted up in a room specially devoted to it, and was protected on all sides, except where the rays of light had to pass, with cotton-wool and large bottles of water. A heliostat reflected a beam of sunlight in a constant direction, and it was received on an appropriate arrangement of slit, lenses, prisms, etc., for projecting a pure spectrum. Results were obtained in the months of July, August, and September; and they are given in the paper graphically as a curve, the maximum being in the ultra-red, and the minimum in the ultra-violet. Taking the maximum at 100, the following are the mechanical values of the different colors of the spectrum:

Ultra-red	100
Extreme red	85
Red	73
Orange	66
Yellow	57
Green	41
Blue	22
Indigo	8½
Violet	6
Ultra-violet	5

A comparison of these figures with those usually given in text-books to represent the distribution of heat in the spectrum, is a sufficient proof that the mechanical action of radiation is as much a function of the luminous rays as it is of the dark heat-rays.

The author discusses the question "Is the effect due to heat or to light?" There is no real difference between heat and light; all we can take account of is difference of wave-length, and a ray of a definite refrangibility can not be split up into two rays, one being heat and one light. Take, for instance, a ray of definite refrangibility in the red. Falling on a thermometer it shows the action of heat, on a thermo-pile it produces an electric current, to the eye it appears as light and color, on a photographic plate it causes chemical action, and on the suspended pith it causes motion. But all these actions are inseparable attributes of the ray of that particular wave-length, and are not evidences of separate identities.

The author enters into some theoretical explanations of the action of the different parts of the spectrum, but these can not well be given in abstract.

An experiment is given by which sunlight was filtered through alum, glass, and water screens, so as to cut off the whole of the ultra-red or dark heat-rays. The ray of light which was thus freed from dark heat was allowed to fall on the pith surface of the torsion apparatus, when it produced a deflection of 105°. When a solution of iodine in disulphide of carbon was now interposed the deflection fell to 2°, showing that the previous action was almost entirely due to *light*. With a candle tried under the same circumstances, the light filtered from dark heat produced a deflection of 37°, which was reduced to 5° by interposing the opaque solution of iodine.

In order to obtain comparative results between disks of pith coated with lampblack and with other substances, a torsion apparatus was constructed, in which two or more disks could be exposed one after the other to a standard light. One disk always being lampblacked pith, the other disks could be changed so as to get comparisons of action. Calling the action of radiation from a candle on the lampblacked disk 100, the following are the proportions obtained:

	Degrees.
On Lampblacked pith	100
Iodide of palladium	87.3
Precipitated silver	56
Amorphous phosphorus	40
Sulphate of baryta	37
Milk of sulphur	31
Red oxide of iron	28
Scarlet iodide of mercury and copper	22
Lampblacked silver	18
White pith	18
Carbonate of lead	13
Rock-salt	6.5
Glass	6.5

In consequence of some experiments tried by Profs. Tait and Dewar, and published in *Nature*, July 15th, 1875, the author fitted up a very sensitive apparatus for the purpose of carefully examining the action of radiation on alum, rock-salt, and glass. The source of radiation was a candle. Perfectly transparent and highly polished plates of the same size were used, and the deflection was made evident by an index-ray of light. Taking the action on the alum at 100, that on the rock-salt in five successive experiments was 81. 77.3, 71, 62.5, 60.4. This increasing action on the alum was found to be caused by efflorescence, which took place rapidly in the vacuum, and rendered the crystal partially opaque. A fresh alum plate being taken, this and the rock-salt were coated with lampblack and replaced in the apparatus, the black side away from the source of radiation, so that the radiation would pass through the crystal before reaching the lampblack. The action of radiation was in the proportion of blacked alum 100 to blacked rock-salt 73.

The author describes a torsion-balance in which he is enabled to weigh the force of radiation from a candle, and give it in decimals of a grain. The principle of the instrument is that of W. Ritchie's torsion-balance, described in the *Philosophical Transactions* for 1830. The construction is somewhat complicated, and can not be well described without reference to the diagrams which accompany the original paper. A light beam, having two square inches of pith at one end, is balanced on a very fine fibre of glass stretched horizontally in a tube, one end of the fibre being connected with a torsion-handle passing through the tube, and indicating angular movements on a graduated circle. The beam is cemented to the torsion-fibre, and the whole is inclosed in glass and connected with the mercury-pump and exhausted as perfectly as possible. A weight of 0.01 grain is so arranged that it can be placed on the pith or removed from it at pleasure. A ray of light from a lamp reflected from a mirror in the centre of the beam to a millimetre-scale four feet off shows the slightest movement. When the reflected ray points to zero, a turn of the torsion-handle in one or the other direction will raise or depress the pith end of the beam, and thus cause the index-ray to travel along the scale to the right or to the left. If a small weight is placed on one end so as to depress it, and the torsion-handle is then turned, the tendency of the glass fibre to untwist itself will ultimately balance the downward pressure of the weight, and will again bring the index-ray to zero. It was found that when the weight of the 1-100th of a grain was placed on the pith surface, the torsion-handle had to be turned twenty-seven revolutions and 353°, or 10,073° before the beam became horizontal. The downward pressure of the 1-100th of a grain was therefore equivalent to the force of torsion of the glass thread when twisted through 10,073°.

The author next ascertained what was the smallest amount of weight which the balance would indicate. He found that 1° of torsion gave a very decided movement of the index ray of light, a torsion of 10.073° balancing the 1-100th of a grain, while 10.074° overbalanced it. The balance will therefore turn to the 99-100,000,000th of a grain.

Divide a grain weight into a million parts, place one of them on the pan of the balance, and the beam will be instantly depressed.

Weighed in this balance the mechanical force of a candle twelve inches off was found to be 0.000444 grain; of a candle six inches off, 0.001772 grain. At half the distance the weight of radiation should be four times, or 0.001776 grain; the difference between theory and experiment being only four millionths of a grain is a sufficient proof that the indications of this instrument, like those of the apparatus previously described by the author, follow rigidly the law of inverse squares. An examination of the differences between the separate observations and the mean shows that the author's estimate of the sensitiveness of his balance is not excessive, and that in practice it will safely indicate the millionth of a grain.

One observation of the weight of sunlight is given: it was taken on December 13th; but the sun was so obscured by thin clouds and haze that it was only equal to 10.2 candles six inches off. Calculating from this datum, it is seen that the pressure of sunshine is 2.2 tons per square mile.

The author promises further observations with this instrument, not only in photometry and in the repulsion caused by radiation, but in other branches of science in which the possession of a balance of such incredible delicacy is likely to furnish valuable results.

* Abstract of a paper read before the Royal Society, February 10th, 1876.

COLORS AND THEIR EFFECTS UPON THE HUMAN SYSTEM.

IN relation to Dr. Ponza's statement of the curious effects of colors and the curative power of the solar rays upon lunacy and other mental diseases, accounts of which we recently published, Dr. Newbery, of this city, in a lecture before the Polytechnic American Institute, states that he advanced the same ideas several years ago:

"I stated that as early as the year 1831 I first announced my discovery, which I have promulgated with additional facts from time to time, that there are but three—not seven—elementary colors; namely, pink, yellow, and blue; and those are the elements of darkness (black), not elements of light. Synthetically speaking, the mixture of all colors makes black; analytically, light. The elementary colors are most perfectly illustrated by carmine, gamboge, and Prussian blue. The yellow and blue rays are more easily seen through the prism, where the elements of their impurities are thrown off into their respective lines or angles in relation to light. The pink ray, being scarcely visible, mingles on each side with the darkness because it has the least affinity with light, and is better seen in binary compounds; as, for instance, with yellow in the red and orange, and with blue in the violet and purple. And in order to be able to distinguish any colors, we have the three elementary colors organized in the eye, forming a membrane called *pigmentum nigra* (black pigment), behind which there is a luminous membrane; both, in combination, are the recipients of the influence of color and light.

"The colors and rays of light also relate to the physical temperaments as stimulants: the yellow color, or ray of light, to the nervous temperament, which is distinguished by a large brain and prominent motor, sensitive and sympathetic nerves; the pink color, or ray of light, relates to the nutritive temperament, characterized by large, glandular negative and assimilating parts and superabundance of blood; and the blue color, or ray of light, relates to what I denominate the locomotive temperament, indicated by large bones and muscle, and predominance of the gelatinous tissue. The various temperaments may be stimulated by the colors or rays to which, as I indicated, they respectively relate, and are, therefore, capable of producing either a healthy or morbid influence upon different individuals. A person in whom the nervous system is dominant may have it increased or excited to prostration by the influence of yellow color, or ray of light. A nutritive-locomotive system may be developed so as to counterbalance the excessive nervousness by the use of purple color, or ray of light. A weak nutritive system may be developed by the influence of pink color, or ray of light, while the same would be injurious to any one of plethoric nature. A weak locomotive temperament may be strengthened by the influence of blue color, or ray of light, while the same would excite a strong person to work or make him irritable. The green color, or ray of light, excites the nervous-locomotive system; the red color, or ray of light, the nervous-nutritive. So that sick or unbalanced persons should have the color of the walls, ceiling, carpets, window-shades, etc., of their particular apartments properly adapted to develop an equilibrium of their physical temperaments, which is the only condition of perfect health and long life required by nature and overlooked by man. All our public assembly-rooms should be of neutral colors, with pictures of various subjects to suit the different tastes, so as to produce a neutral effect in the aggregate, in order that each individual might be suited according to his sympathetic and comprehensive attraction."

FIG. 1

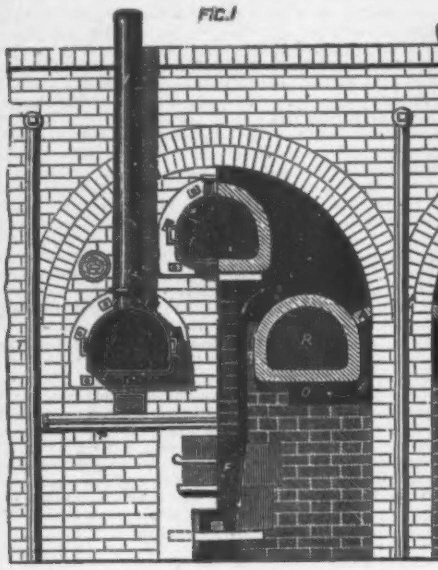


FIG. 2

FIG. 3

FIG. 5

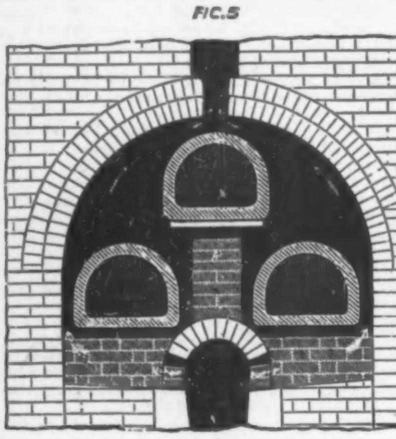


FIG 6

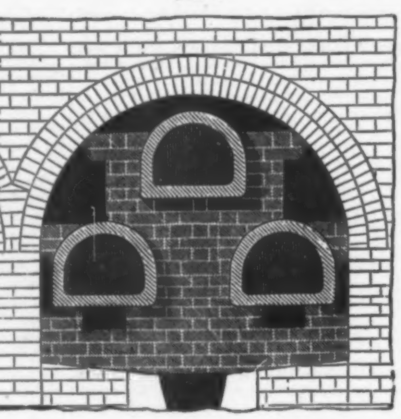
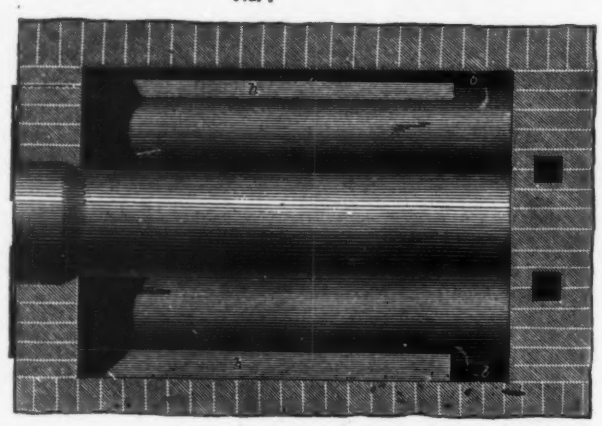


FIG. 4



SETTING GAS-RETORTS.

RETORT-SETTINGS.

Figs. 1, 2, 3, and 4 refer to the same system of setting three clay-retorts in a bed, each 15 inches by 12 inches internal measure.

Fig. 1 represents the bed, one half in elevation, the other half having the front wall removed, in order to show the entrance to flues, *o o* (Fig. 2), which extend underneath each retort, and communicate with the vertical flues, shown in dotted lines in Figs. 3 and 2, and partly in section in Fig. 3, and marked L, and in Fig. 4 in plan.

The frame of furnace-door is secured by a horizontal bar, P, and bolted at both ends to the buckstaves, T T, this method being sometimes adopted instead of bolts embedded in the brickwork. F is the furnace, the sides being formed of large blocks, which as already stated, are more durable than bricks, the quality of material in both cases being alike. These blocks possess the further advantage of offering facilities for repairs when the furnace becomes much enlarged by the action of the fire, and the consumption of coke for carbonization is excessive. For carrying these repairs into execution, the furnace being "let down," and cold, the door and frame are removed, and the brickwork of the front wall is cut away, to enable the workmen to remove the blocks, and replace them by others, so rendering the furnace in its primitive state. This done, the wall is built as before, and the door placed ready for action. It should be observed that in "letting down" a setting, the coke of the last charge should always be left in the retorts, the general impression being that this prevents them from cracking.

In Fig. 1, *g g* are guard-tiles to protect the lower retorts from the direct action of the fire at these points; *λ* is a course of tiles, shown in plan, Fig. 4, placed so as to form a flue, *b*, from the back of the retort to the front. There is only one fire-bar of 2-inch square wrought-iron, the two bearers being of the same material. The fire-bar projects to the level of the front of the wall, a space existing between the former and the frame of furnace-door, and though this space, as well as underneath the furnace, passes the supply of air to the fuel. This method affords greater facilities for clinkering than when the bar or bars are within the wall, as this can be done at intervals without opening the furnace-door.

Some engineers employ cast iron furnace-bars, and place four or five of these in the furnace in a similar way to that of a steamboiler. According to our experience, cast-iron for the purpose has but comparatively limited durability. A further disadvantage of this method is, that the narrow apertures for the passage of the air are speedily obstructed with clinkers, rendering extra labor necessary to remove them. Against this, it may be urged that the wide spaces permit of a portion of the coke falling through, which would be prevented with the narrow spaces, and to a certain extent this may be correct; but, as in all well-conducted establishments the residue from the ash-pans has its proper value, no loss on this score arises. Wrought-iron bars, as shown, with one or two in a furnace, are very generally used; and, beyond all question, that material is far superior to cast-iron, either for bars or bearers.

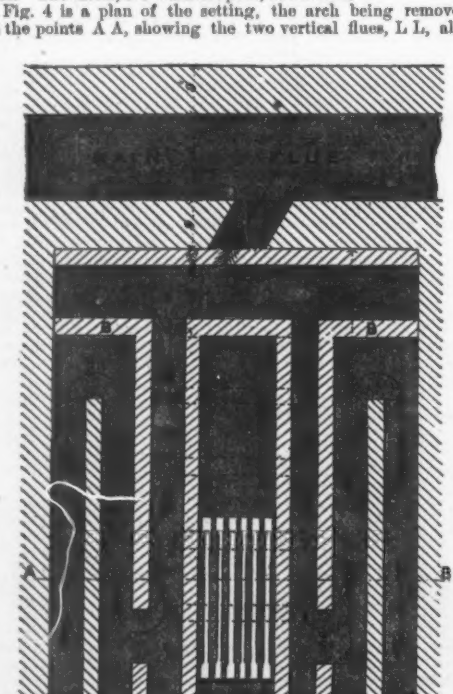
In the same figure is represented one of the sight-boxes, as well as a clearing-out box for the flue.

Fig. 3 is a longitudinal section direct through the centre of the bed, showing the arch, J, immediately over the furnace-door, the front wall being 14 inches thick; also the fire-brick lintel, *e*, with the dead-plate attached to the door-frame, which facilitates clinkering.

The top retort is supported by the piers, P P, and their respective slabs. The *massif* is represented of solid brickwork; but this, as before stated, when economy is necessary, can be replaced with fire-brick rubble. It is imperative, however, that all the bricks in immediate contact with the fire should be fire-bricks. L is the flue, at the junction of the two vertical flues.

Fig. 2 is a section through the line B B, all the letters of reference corresponding. The vertical flues, shown in dotted lines, connect the flues *o o* with the main flue, the damper, *d*, closing the communication between the beds and the main flue. The latter, for want of space, is omitted.

Fig. 4 is a plan of the setting, the arch being removed at the points A A, showing the two vertical flues, L L, also



6 . 5

the entrances to the two flues, *b b*, formed by the tiles, *λ λ*, which convey the caloric along the sides of the lower retorts into the flues *o o*, hence to the vertical flues, as indicated by the arrows.

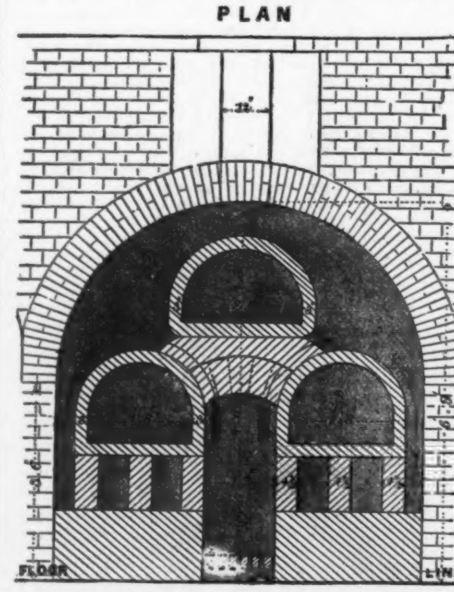
With a setting of this kind, no obstruction is offered to the passage of the caloric, part of which is conducted direct to the retorts, the other part being conveyed by the flues, as described, the waste heat being controlled by the damper.

Fig. 6 represents a similar setting to that described, but in this, instead of the retorts being left unsupported at the sides, they are enclosed with 4½-inch walls, built about a foot apart. Some engineers adopt a medium plan, by placing a number of guard-tiles at intermediate distances against the sides of the retorts.

The first four figures represent the manner we have invariably set retorts—that is, so far as possible detaching them from each other, and without cross-walls; and although this may be contrary to the opinion of many engineers, we believe it to be the correct method, for reasons about to be given.

An erroneous impression exists that good first-class clay-retorts are compact and free from pores or cells, whereas such articles are exceedingly cellular and friable, and for the purpose of transport, in order to prevent breakage, they require to be carefully packed between battens. The best clay-retorts neither expand nor contract when heated to the temperature necessary for carbonizing coal. Fire-bricks, on the contrary, expand by heat; consequently, the arch and brickwork, as shown in Fig. 6, when heated, will press against the retorts and cause them to crack. To this circumstance, we believe, is mainly due the breakage of clay-retorts; for, as already observed, we have on several occasions taken them out entire after lengthened active service. These were set without transverse walls, whereas, with them, each retort would, undoubtedly, have been broken into several pieces.

PLAN



ANOTHER PLAN, BY T. HALL.

The method of isolating the retorts is very generally applied in works on the Continent and, we believe, in Scotland, where clay-retorts were first practically applied

It may be observed that there is no other article employed in gas manufacture where excellence is so desirable as in clay-retorts and the fire-bricks of the furnaces, and in all cases, the best description that can possibly be obtained, should alone be employed, without regard to the slight difference of cost. To demonstrate the importance of this, we

may remark that an oval retort, of first quality, 21 in. by 14 in. by 8 ft. 6 in. internal measure, will, in its lifetime, carbonize from 300 to 400 tons of coal, producing nearly 3,000,000 to 4,000,000 ft. of gas. But if indifferent retorts are used, which are liable to crack, a considerable portion of the gas may be lost, and, by the expenditure of a few shillings only upon each retort, this might be saved. The best retorts we have met with are sold by *weight*, and they command their price. In England, they are estimated at per foot run, the lowest price often commanding the market, irrespective of quality.

We do not pretend, however, that the highest-priced retorts are always the best; but, as a rule, a manufacturer who acquires a reputation for excellence of production generally commands his price, and the quality of retorts being assured, a moderate difference in price should never be considered a difficulty to their employment.

Respecting the bricks suitable for the interior of the furnace, it is clear that perfection is one of the greatest wants in a gas-work, and if bricks could be obtained that would last two years, without any appreciable enlargement of the furnace, they would be invaluable.

Fig. 5 shows another system of setting retorts, in which the heat passes from the furnace in the direction of the arrows, up the sides of the outside retorts, and so in to the flue on the crown of the arch, and from thence to main flue. This is similar to Clegg's setting of iron retorts already mentioned. According to this system, the arch represented over the furnace is continued the whole length of the bed, and has five or six nostrils, as represented by N N, on each side, and between these are built the transverse walls for supporting the lower retorts. The centre retort is supported on its pier. The only passage for the heat is, therefore, through the nostrils, up the side of retorts, and so off to the chimney.

Another plan, by T. Hall, is shown as follows:

As will be seen from sketch, the design is for a setting of three D-retorts in one oven over the fire. A A, supports for top retort, consist of two rings of arch bricks, which will stand much better than the usual saddle-piece; the wall B B is built close up to top of arch, and, if preferred, can be nine inches thick. The spaces in front, on plan, are movable sights for access to clean flues under two bottom retorts.—*Journal of Gas-Lighting.*

A MULTI-CYLINDER ENGINE.

By WILLIAM H. BILLING, East Saginaw, Mich.

THIS engine operates in a manner the reverse of that of ordinary motors, inasmuch as it is the engine that revolves while the shaft and crank are stationary. Instead of one, or even three cylinders being employed, as many may be used as can be grouped around the rim of the fly-wheel without causing too great complication of parts. Dead centres are, therefore,

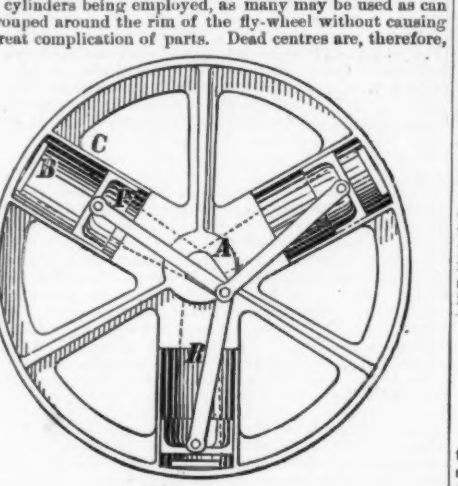


Fig. 1

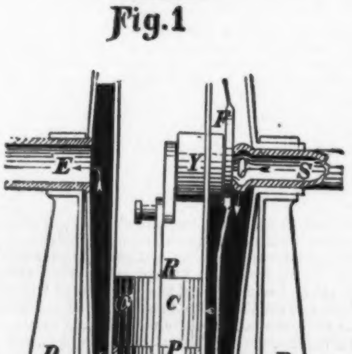


Fig. 2

MULTI-CYLINDER ENGINE.

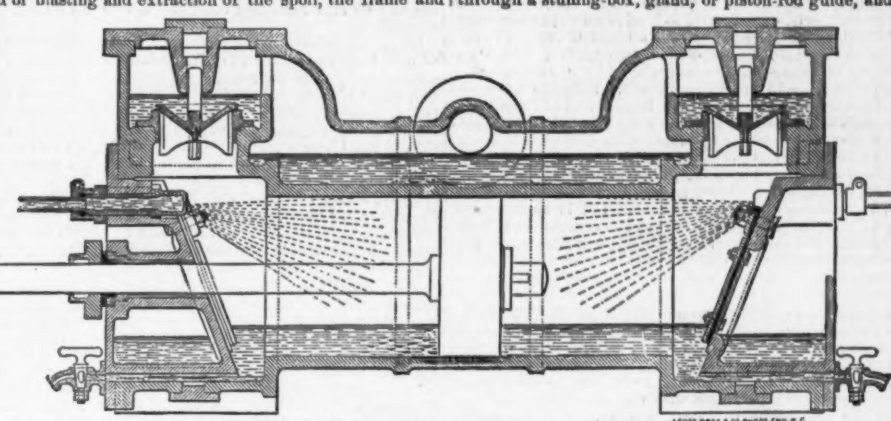
non-existent; and the machine, paradoxical as it may seem, reduces itself to a self-rotating pulley-wheel.

In Fig. 1, a front view, A is the stationary crank, C is a light wheel, and the three cylinders grouped symmetrically about the latter furnish the necessary weight at the rim; the cylinders take steam at the rear end only, B being the steam-port and the dotted lines indicating the steam passages. In Fig. 2 an economical arrangement of parts is exhibited in section. Here the engine has bearings in the wheel-hubs, through one of which, S, the steam enters, as shown by the arrow, and through the other, E, the exhaust is had. The crank-shaft is merely a continuation of the steam-pipe, a suitable stuffing-box being provided at Y. On the pipe, also, and inside the steam chamber is fixed the eccentric F, which gives motion to simple valves B at the cylinder ends. The exhaust-pipe might be run through a stuffing-box and used as a shaft for pulleys, or the engine might be enclosed and the exhaust led to the other side of the pistons as in the Willan three-cylinder engine.

[Engineering.]

NEW AIR COMPRESSOR.

WE reproduce from the *Revue Industrielle*, a drawing and description of an air compressor designed by MM. Dubois and François, to drive drills for sinking shafts, and one of which is now in operation at Wérister, near Liége. The arrangement consists of an air reservoir of 280 cubic feet capacity, of which from one fourth to three eighths is occupied by the injection water, and the remainder by the compressed air. Two iron pipes, 2 in. in diameter, conduct the air to the drills, which are four in number, and on the Dubois and François system. The diameter of the cylinder is 3¼ in., and the stroke 7¾ in. The frame is formed of wood and iron, and has two vertical iron standards 3$\frac{11}{16}$ in. in diameter; each standard carries a horizontal screw, and the drill is mounted on a nut moving on the screw, and having a range of half a circle. During the period of blasting and extraction of the spoil, the frame and



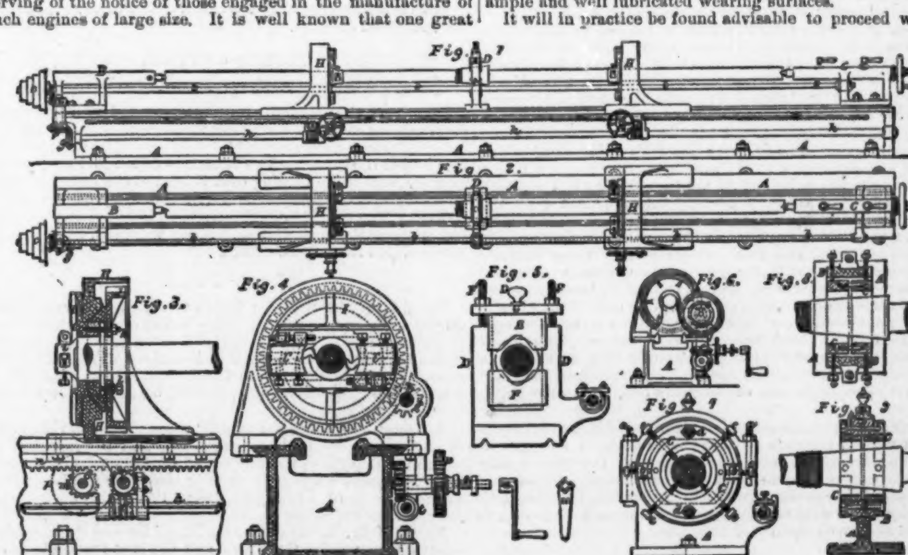
NEW AIR COMPRESSOR.

drills are lifted, and when at work it rests upon a timber substructure. The compressor is intended to deliver air at a pressure of 3½ atmospheres. It is actuated by a steam cylinder 29½ in. stroke and 13¾ in. in diameter, and the piston rod is attached direct to the piston of the compressor. The compressor cylinder has the same stroke and diameter as the steam cylinder, and the ends are inclined as shown in the section; they are fitted with two valves for the admission of the air, and at each end there are two gun-metal valves arranged as shown. Into each end of the cylinder there penetrates the perforated extremity of a pipe, and through these, at every stroke, water is injected against the piston and the sides of the cylinder to prevent the heating due to compression. This water is not allowed to accumulate beyond the level shown in the section, and, as mentioned above, an overflow being provided. The following advantages are claimed for the arrangement: 1. The area of the inlet valves is very large. 2. The water injection ceases at the moment when it becomes unnecessary, that is to say, when the air reaches in the cylinder the same pressure that it has in the reservoir. 3. The compressor may be worked at a speed from 40 to 50 strokes per minute. At the coal mines of Wérister it was intended to sink two shafts, each 656 ft. deep, and after two years' working, this is being accomplished, while the results of working with this system have been highly satisfactory.

[Engineering.]

PISTON RODS FOR HORIZONTAL ENGINES.

WE give engravings of arrangements for turning the piston rods of horizontal engines, which appear to us well deserving of the notice of those engaged in the manufacture of such engines of large size. It is well known that one great



LATHE FOR TURNING PISTON RODS.

objection to horizontal and inclined steam and other cylinder engines and pumps as compared with the vertical type is the unequal wear of the cylinder and its piston, or bucket and rod, these parts, in the ordinary construction, resting on and grinding against the lower side of the cylinder and glands. The inconvenience is not felt to a very serious extent in smaller engines or machines, but with a stroke of 3 ft. or more the undue wear and grinding action becomes very inconvenient, causing also leakage at the piston (although not always observed), and at the piston-rod gland. The plan of prolonging the piston-rod through the back cylinder cover, and supporting it beyond it with the view of thereby also supporting the piston, is utterly fallacious in theory, and practice has proved it to be so. This will be obvious if we look upon the piston-rod as a beam supported at each end by the guide-blocks or shoes, and loaded with its own distributed weight, and with that of the piston thereon between the said end supports. The upper fibres of the piston-rod will then clearly tend to be in compression, and the lower fibres in tension, that is, the piston-rod has a strong tendency to bend, and consequently the piston and rod will bear with nearly the whole of their weight on the lower part of the cylinder and gland, although a small part of the weight is borne by the guides, and also by the glands if, and as long as, the latter fit well round the piston-rod.

The object of the arrangements we are about to describe, and which have been designed and patented by Mr. W. A. G. Schönheyder, of 34 St. Augustine's terrace, Camden Town, London, is to obviate the aforesaid undue friction and wear, and thereby consequently effect also a saving in power and lubricating material. For this purpose Mr. Schönheyder continues the piston-rod out at the back end of the cylinder through a stuffing-box, gland, or piston-rod guide, and forms the piston-rod with such a permanent set, or camber, that when it is loaded with the weight of the piston, and is supported at the ends on the crossheads or other outer guides, it shall then be straight, or nearly so, none of the weight or practically none coming on the lower parts of the cylinder or its glands; or, when it is inconvenient to continue the piston-rod through the back of the cylinder, Mr. Schönheyder forms the piston-rod similarly with a suitable camber, and causes the crosshead or its equivalent to carry the weight of piston and piston-rod in any suitable manner, such, for instance, as by providing the crosshead with rigid continuations going back on each side of the cylinder and there supported and working in guides.

In carrying out this system of construction, the amount of deflection or curved bend of the piston-rod caused by the full weight of the piston and by its own distributed load or weight is first calculated by the well-known formula, or found by reference to a table specially arranged therefor. The piston-rod is then given a bend or camber, which may be slightly in excess of the said deflection, the camber given to the piston-rod being of such an amount and nature that when the piston-rod is loaded with the full weight of the piston and supported on the guides at the ends in the exact manner in which it is intended to work, whether horizontal or inclined, it shall then assume a perfectly straight form, or as near as may be. A piston-rod made as described will consequently, when placed in its cylinder with its piston on, be supported entirely on the guides, and neither the piston-rod nor the piston will have any tendency to wear more on and against the bottom than on and against the sides or top. The whole weight of the piston and rod being thus supported outside the cylinder it can and ought to be there properly distributed, that is, the crosshead blocks or equivalent parts should have ample and well lubricated wearing surfaces.

It will in practice be found advisable to proceed with this manufacture in the following manner: First calculate the weight of the piston and the piston-rod separately, or by preference ascertain their weight by actual weighing. The finished size of the piston-rod is, of course, determined upon beforehand, and from these data the amount of camber is calculated or otherwise found, and the piston-rod is next formed with proper centres in its ends, and a temporary journal formed on or bolted on centrally with the place intended for the piston. Mr. Schönheyder then gives the piston-rod in its black or unfinished state a suitable camber, which is by preference slightly in excess of the calculated or tabulated amount in order to enable the workman afterwards by adding slightly and gradually to the weight of the piston (which is usually possible and not objectionable), so to balance the load that the rod when finished and supported

and loaded as when working shall be perfectly straight. Another object of giving the rod a little excess camber is to allow for weakening by wear and subsequent turning down and lightening of the rod. Mr. Schönheyder then places the bent piston-rod in a lathe between centres, the arrangement being that here illustrated. In the views there given Fig. 7 is a front elevation of a suitable plummer-block or collar-plate, which may be placed and used on any ordinary slide rest lathe, and wherein that part of the piston rod may be held, which is to take the piston; Fig. 8 is a horizontal section of plummer-block; and Fig. 9 a vertical cross section.

In these figures A is the body of the plummer-block formed with suitable lugs or flange for resting it on and bolting it to the lathe bed. It is formed with a cap or upper part, which is united with the lower part by means of bolts a^1. It is bored out circularly, and in it fits so as to be able to revolve a circular ring or collar-piece B, which is formed internally as a circle with two flat sides, as shown. The ring B has two lugs b on each side, each tapped to receive an adjusting-screw c. Inside the collar-piece B there is a block C formed to suit the hole through B, and made in two halves, which are formed with flanges outside, and united by bolts d passing through oval holes in the collar-piece B. Suitable parts are cut out in C to give room for the lugs b, and at e are eight set screws, four on each side of the body A. The two halves of B are also held together by steady pins f.

The use of this collar-plate is as follows: The required amount of camber having been given to the piston-rod, the block C is by means of the set screws c moved to an equal extent, say to the right, and the bent rod is then passed through the collar-plate and placed in the centres of the lathe and secured. The set screws e are so adjusted that the piston-rod and collar-bearing can rotate freely without any strain or springing of any sort, the convex side of the piston-rod having of course also been set towards the right in the first instance, or pointing in the same direct on as the block C. This latter is now brought back to its normal position, and to facilitate this a scale is provided on each of the lugs b, as shown. This movement is accomplished by turning the set screws c in a direction opposite to that imparted to them in the first instance. It will then be found that the piston-rod has been sprung into a straight line, or nearly so. The piston-rod being thus properly adjusted (in the mode described, or in a slightly modified manner, which will readily suggest itself to an experienced workman), the bolts d are tightened up, and the turning may then be proceeded with in the usual manner, but by preference with two tools starting simultaneously and travelling in opposite directions.

Instead of the piston-rod revolving, however, a special lathe may be employed in which the piston-rod is held stationary and screwed down in the middle, as aforesaid, and the cutting tools are caused to revolve round it. A lathe of this kind, which has been designed by Mr. Schönheyder, is represented by Figs. 1 to 6, Fig. 1 being a side elevation, Fig. 2 a plan, and Fig. 6 an end elevation; while Figs. 3, 4, and 5 are enlarged views of details.

In these various views A is the lathe bed, having lugs cast on for holding down bolts as shown; B is a fixed poppet-head with long projecting boss and "centre" as shown. It carries one end of the driving-shaft b with cone-pulleys c, and with bevel wheels driven by it, and transmitting motion to the feed-spindle h. C is a movable poppet-head also formed with a long projecting boss and "centre" as shown. It carries the other end of the driving-shaft b. D is a centre-bearing bolted to the lathe bed. It is shown enlarged in front elevation at Fig. 5. It serves the purpose of pressing down and holding the middle part of the piston-rod, and is made with top and bottom block E and F, and with cap or plate G, which by means of the bolts F^1 can be screwed down, and the piston-rod thereby sprung down to its straight position.

It will be observed that the centre-bearing D fits on V pieces formed along the top of the lathe bed. H, H, are two movable headstocks, which contain the revolving cutting tools; they are shown in section and elevation to a larger scale at Figs. 3 and 4 respectively. H is the body of the headstock, which fits and can slide along the lathe bed. It is formed with a central opening, wherein fits the hollow revolving block I with tool holders i, i, wherein the cutting tools are secured in any usual manner; or it might be a saddle or sliding cap. J is a counter block or back, which is formed in one with a spur-wheel that gears with a spur-pinion j, which slides along the driving-spindle b, turning with it by means of feather and groove or otherwise. The revolving-blocks I and J are united by studs k, and adjusted against one another by means of set screws l, so as to revolve freely and steadily in and on the body H.

The feed is effected as follows: The body H has a lug below, forming a bearing for a small pinion m, which gears into a rack n fixed to the lathe bed A. On the spindle o of the pinion m there is another pinion p gearing into a pinion q on the spindle r, which also carries a worm-wheel s that gears with a worm t, which slides along and turns with the feed-spindle by means of feather and groove or otherwise. By pulling the pinion p out of gear with the pinion q the automatic feed may be thrown out of gear, and the feed worked by hand by means of a hand-wheel or handle u on the square end of the spindle o. Change wheels may be employed for altering the self-acting feed, as is usual with ordinary lathes. The headstocks can thus be moved automatically or by hand along the lathe bed with any required speed. The feed-spindle h has its bearings at each end of the lathe bed, and in the headstocks.

In order to turn a single-ended piston-rod Mr. Schönheyder forms it with or attaches to it at the cross-head end a temporary end, whereby it may be formed with the proper camber. The end to be turned can then be finished by means of the apparatus above described. Altogether Mr. Schönheyder's plans have been very carefully worked out, and they are, as we have said, well worthy of attention.

PARIS GREEN.

In the February number of the *Scientific Farmer* I notice an able article on "The Colorado Potato Beetle in Massachusetts," by A. S. Packard, Jr., in which he recommends Paris green, mixed with flour, as an artificial remedy. After using it for three years mixed with flour, with water, and with gypsum (sulphate of lime), I find the latter, mixed 1 lb. to 30 lbs., the most economical form, and to give better satisfaction in the end, it being a valuable fertilizer for that crop; and sprinkled over them frequently, gains two important points. It should be applied early in the morning, while the vines are yet damp with dew, and the operation repeated as often as the rains wash or the winds blow it off.

B. K. BATCHELOR.

Plainville, Mich.

UNHEALTHY TRADES.

A LECTURE BEFORE THE SOCIETY OF ARTS, LONDON, BY DR. B. W. RICHARDSON.

(Continued from page 279.)

Aniline Vapor.

SINCE the manufacture of the new aniline dyes has become such a great commercial pursuit, serious injuries have occurred to the workmen employed in the manufacture. The first decisive injury from this substance which attracted marked attention occurred in a lad sixteen years of age, who was brought into the London Hospital, from some aniline works in which he was engaged, on the 9th of June, 1861. The lad had been found in a state of insensibility, in the interior of a vat used for the manufacture of aniline. He was pale and cold; but that which attracted most attention was the extreme blueness of his lips. The lad recovered, but on the following day he still remained blue, and his breath smelt strongly of aniline.

Three years later, Dr. Kreuser, of Stuttgart, reported a set of new facts respecting the influence of aniline on the industrials employed in its manufacture. He showed that the vapor, when it does not act to the extent of producing insensibility, causes violent dry, spasmodic, cough. He also noticed, for the first time, that the vapors produced ulceration of the skin in the lower extremities, with much pain and swelling. The ulcers rapidly healed when the workmen were removed from the influence of the vapors.

Later, Messrs. Knaggs and Mackenzie in England, and M. Chevalier in France, discovered that a peculiar and extreme neuralgia is induced by the vapor of aniline. The neuralgic attacks begin with an intense nervous pain in the head, and a giddiness increasing almost to faintness.

Two French investigators, Tardieu and Roussi, have made some important researches on the physiological action of the red and yellow dyes, by which they have determined that, when animal bodies are subjected to these substances, a fatty change takes place in the minute structure of the vascular organs. The liver is made specially to undergo fatty degeneration; the tissues are also dyed with the color, and from the dye-stuff extracted from the animal organs the experimentalists dyed a skein of silk.

We have no evidence as yet that these phenomena of fatty change have ever occurred in the human subject, although it is fairly to be inferred that a long exposure to the vapor would lead to this result. The mischiefs actually inflicted are sufficiently important. They include *insensibility, followed by blueness of the skin, cyanosis, ulceration of the skin*, and *acute neuralgia*, all new maladies to be entered on our catalogue of industrial disease.

Nitro-Benzole.

The employment of nitro-benzole in chemical works gives rise to another source of danger, which more than once has been fatal. In all cases long exposure to the vapor of this substance produces nervousness and stupor, but when the vapor is inhaled in the concentrate form, the drowsiness, after three or four hours, passes into stupor and intoxication, and finally into complete coma, or apoplectic sleep. The mind remains clear until the stupor suddenly comes on, and then the insensibility is complete. The body falls precisely as in apoplexy, and death ensues in about five hours.

Dr. Letheby, who of all observers has most carefully inquired into the action of nitro-benzole, is of opinion that the poison is reduced in the body into aniline by giving up its oxygen, but that on the surface of the body the opposite condition is in progress, by which the salts of aniline are oxidized, and are converted into mauve or magenta purple. I have learned of another mischief incident to the manufacture of nitro-benzole. In making it, by acting on benzine with nitric acid, vapor of hypo-nitric acid is freely evolved. This vapor produces great bronchial irritation, nausea or vomiting, and colic. Chevalier has reported on the same facts, and has added others which in England have not been noticed so evidently. He says that the process of washing the nitro-benzine is more painful than the making of it, and that the vapor of benzine itself induces intense headache, a fact I can fully confirm.

Thus *coma* and *apoplexy* are again added to our schedule of the industrial diseases.

EFFECTS OF FUMES.

Resinous Fumes.

Some very simple occupations are attended with bad results from trifling causes. For fixing the hair of brushes, such as shaving-brushes, a compound is made by pouring melted resin into boiled linseed-oil. The workman dips the tuft into this solution, and while leaning over it inhales the fumes of resin. Great distress of breathing and irritation are produced by this process. The cough is suffocative and becomes in time chronic, with persistent irritation. Many workmen have to leave the business from these causes.

Copper Fumes.

The first of the metallic fumes to which I have to direct attention is copper-smoke. The action of this smoke is to produce asthmatic seizures in the older operatives, in addition to the bronchial irritation which it excites. The influence of the smoke is destructive to the surrounding vegetation; its influence on vegetation may, indeed, be summed up in one word—corrosive.

Although the fumes are called "copper"-smoke, the amount of copper is exceedingly minute. One half per cent only exists in the deposit in the interior of furnace-chimneys, and so little is present diffused in the air that none can be detected at the distance of a few yards from the works, except when the smoke is extremely dense.

The late Dr. T. Williams, F.R.S., of Swansea, from whose analyses we receive the above and the best facts, states that the products of the smelting operation are divisible into two parts, (*a*) the gaseous and non-condensible, (*b*) the solid and condensible, fumes.

The fumes which condense in the culverts contain oxide of iron, oxide of lime, with traces of antimony and other metals, in the proportion of about 44 per cent pure copper, 5 per cent arsenious acid, 10 to 15 per cent sulphur; and sulphuric and sulphurous acids in combination, 15 to 20 per cent; water, from 14 to 19 per cent.

The smoke which escapes into the air from the chimneys contains coal-smoke in abundance, traces of arsenic, and sulphurous and sulphuric acids. Williams reckoned that 829,790 cubic feet of sulphurous acid were sent into the Swansea district atmosphere every week from the copper-smelting works on the Tawe. The acid can be detected in the atmosphere twenty miles from the works. Sulphuric acid is also diffused with sulphurous. According to Williams, for every fifteen parts of sulphurous acid in the smoke there exists one of sulphuric acid in combination. Upon these acids is chargeable the destruction of the vegetation of the district.

The cattle feeding in the locality are affected with a disease termed by the Welsh farmers *effydrdod*. This disease is an inflammation of the *periosteum*, or membranous covering of bone. The bone becomes thickened in the neighborhood of joints. There is inflammation of the joints with effusion of fluid into them. The bones are prone to fracture. The teeth sometimes fall out and sometimes decay. Williams, whose description is here again followed, attributes the symptoms solely to the sulphurous and sulphuric acids. These acids, brought down by the rain, render the grass sour, and the eating of the grass causes the malady.

It is admitted that the copper-smelters are subjected to bronchial affections from their occupation, but their families appear to be exceedingly healthy and specially free from epidemic disease. Indeed, the accomplished author to whom I have so many times referred, in treating on this subject of epidemic disease, has advanced a theory which is singularly interesting and curious. This theory is that the copper-smoke entirely destroys all the poisons of the spreading diseases, so that "if it were possible to obtain a permanent diffusion of copper-smoke in the atmosphere of a given locality, the population of such locality would be permanently exempt from those epidemic diseases whose causative germs, whatever they may be in essence, travel and multiply from place to place in the atmosphere."

I do not indorse this theory, because the germ-theory of disease is to me incomprehensible; but the speculation of Dr. Williams is worthy of remembrance.

Fumes of Mercury.

In the older manufactories the sublimation of mercury was conducted in such a manner as to lead to very serious symptoms of disease. The workers at mercurial mines are now most subject to the danger of mercurial fumes, especially when they are engaged in the outside works, preparing and subliming mercury.

The disease excited by the fumes varies according to the mode in which they are inhaled. The most frequent symptoms are salivation and ulceration of the mouth. In some instances the stomach is first affected; there is pain in the stomach, constriction, sleeplessness, and cough. These signs are followed by those of salivation, and in some rare examples, recorded by M. Ferrand, there was a red rash on the body like the rash of scarlet-fever, which lasted for several days, and left rheumatic pains in the limbs.

In yet another class of cases the symptoms are more purely nervous, and are those of neuralgia, accompanied or followed by muscular tremor called significantly mercurial tremor. The whole muscular system is in fact thrown into constant feeble contractions and relaxations, over which the patient can exert no control.

In the extremest forms of disease from mercurial inhalation, the teeth become carious, and even the bones are affected. Some idea of these varied forms of disease may be obtained from the facts that have been collected at Idria, in Austria. Here there are the second best mercurial mines in Europe, and over five hundred men are employed at them. The works for smelting and purifying are about a mile from the mines, but the men change about, so that all are equally engaged at the various parts of the works. In one year, Dr. Hermann found that of 516 men thus employed, 122 were attacked with disease from the mercury, in the following forms: 27 had neuralgia; 14, rheumatism; 6, tremors; 16, salivation; and 2, caries. Hermann states that in the valley of Idria all the people and even the domestic animals are liable to be attacked with mercurial disease in one or other of its phases.

In England it is impossible to collect the facts respecting those who work in mercury with so much precision as is above recorded, but the symptoms, when they appear, are of the same order. They add three new diseases to the schedule—namely, *salivation, mercurial rheumatism*, and *mercurial tremors*.

Fumes of Zinc.

Men engaged in bronze-founding are subject to serious symptoms from inhaling the fumes of oxide of zinc. The fumes rise to the mouth of the workman and settle on the lips, causing sometimes a whitish efflorescence. After long exposure to these fumes there are induced choleraic attacks with shiverings, and severe cramps in the muscles of the legs. Sickness is also induced which may last many days, and the food that is taken seems to undergo a peculiar fermentative change, so that there is constant pyrosis, or water-brash.

The specific action of zinc on the animal economy, for the description of which we are indebted to Dr. Leo Popoff, is amongst the most singular that the study of industrial pathology affords. It adds to our calendar *choleraic disease, cramps of the limbs*, and *pyrosis*.

Phosphorus.

The introduction of the manufacture of phosphorus or lucifer matches, which commenced about forty-three years ago, created a new form of disease caused by the inhalation of the fumes given off from the phosphorus. This disease, an extremely painful one, affected the jawbone of the worker, causing necrosis or death of the bone. It was not detected until the year 1845, when it became well defined in the public hospitals at Vienna. To Dr. Letheby we are indebted for the first light that was shed on the subject in this country. Soon after his report the whole matter came fully under investigation. The mischiefs, when they occurred, were all produced by the use of white phosphorus, the common phosphorus of commerce. In the match manufacture the fumes of the phosphorus were inhaled at every step in the process, from the stirring of the mixture, through the dipping, to the boxing of the matches. While the disease was present I made a very careful investigation of it in respect to its development and course, and reported the facts in one of my lectures on the "Medical History of Diseases of the Teeth," delivered in 1858, and afterwards published. The facts, briefly described from that lecture, are that the symptoms first complained of were pain, deep-seated in the tooth, having, as it were, one tooth for a centre. It was not a toothache, nor was it strictly confined to one particular tooth, but it extended steadily and persistently along the jaw, and was much intensified whenever the jaw was gently percussed or struck. In time the disease became concentrated in the jaw, a slow inflammatory process occurred, and a thickening of the bone ending in death of the bony structure, with attempts, in parts, at regeneration. In fact, what is technically called a true necrosis was developed. In the worst cases, where the patient was not relieved by operative measures, hectic supervened, with copious night-sweats, extreme pain, and even death from exhaustion. It was remarkable that no bones except those of the jaw were affected, even in the worst cases, so that the disease was purely local, and, indeed, was disconnected from the other symptoms of phosphorus-poisoning. I inferred that the malady was due

to a volatile acid of phosphorus, which was absorbed by the saliva, and affected the jawbone whenever the teeth became unsound and the alveolus or edge of the jawbone became exposed. This view accounted for many of the anomalies—namely, that the lower jawbone alone was affected, that the enamel of the teeth escaped injury, and that workers whose teeth generally were sound escaped the injury altogether.

When the phosphorus-disease once commenced, it continued in progress over periods of one, two, or even three years. It was sometimes localized in its extent, so that the teeth only came out, sometimes it extended through the whole of the bone. I compared it in 1858 to a chemical destruction of the bone, with inflammation from the irritation produced by the foreign products of decomposition. I see no reason to modify that definition.

You will observe that in speaking of the phosphorus-disease, I have spoken of it in the past tense. I have done so because, fortunately, the affection is now all but extinct. The discovery made by Lundstrum, of Sweden, that red or amorphous phosphorus could be applied for the production of matches, led to a complete revolution in the match-making business, and to the introduction of what is called the safety-match. By this plan the red amorphous and practically innocuous phosphorus was placed on the box, and the combustible substance put on the match was made of materials that were perfectly harmless to health. Two qualities of safety were secured by the improvement. The match was rendered safer for common use, and the operatives were freed from the invasion of one of the most severe of the industrial diseases. The disease was classified under the title of *phosphorus necrosis* in the records of industrial pathology.

Fumes of Lead.

The fumes arising from the process of lead-smelting are less often sources of injury then they were formerly. Some danger occurs from the inhaling of salts of lead in fine powder, but the greatest danger lies in the manipulation of lead when it is used as white-lead or as a salt. To its action on the body and its importance as a source of disease I proceed, at once, in the next section of our subject.

CLASS II.—INJURIES FROM EXPOSURE OF THE BODY TO CHEMICAL AGENTS, SOLUBLE OR IN SOLUTION.

From the study of the effects of substances inhaled, and productive of injury through their introduction into the body by the lungs and the blood, we pass to the second and succeeding classes printed on our table.

Disease from Absorption of Lead.

Lead is always introduced in the form of an oxide, or of a salt of the metal. It specially affects two of the industrial orders—painters and potters. The painters use lead, as we all know, in admixture with oil and turpentine, to make the common paints that are in daily use for ordinary paint-coloring. The potters use it for what is called glazing the pottery—that is to say, for giving the hard, smooth, shining surface to vessels of earthenware. The painters come in contact with the lead while manipulating with paint; the potters come in contact with it in solution, or rather in suspension, while dipping the earthenware. In these cases, and, as a rule, in all cases where lead is used and becomes injurious from its use, it is first brought into contact with the hand of the workman. It has been usually assumed that in this way the substance is directly absorbed through the skin into the blood, and that the nervous centres are reached by this channel of absorption. I am inclined to question this hypothesis. There is no proof whatever, of an experimental kind, that lead is absorbed by the skin. Solutions of lead may be applied, I had almost said to any extent, over the external surface of the body without effect of a deleterious kind, and I have had the most convincing evidence of some men who have worked in lead for years, that they have never shown a sign of lead-poisoning. The evidence on the whole is to my mind conclusive that in all cases of lead-poisoning the poison is swallowed by the mouth. The workman or workwoman, becoming careless after a time, takes up bread or other article of food with hands soiled with lead. Thus a little lead is taken daily, and in time the mischief is done.

It is one of the peculiarities of this agent of disease amongst the industrial classes that it is a cumulative poison. Some injurious agents are so soluble they are readily carried out of the body when once they have been received into it. They accompany the excretions, and at a brief interval make their escape. Other foreign and injurious substances are of organic character; these are decomposed or broken up in the chemical processes that go on within the body, and so are eliminated. But lead, an inorganic and sparingly soluble substance, is thrown off with great difficulty. Its chief mode of exit is by the excretion from the kidney. For a time this mode of elimination is sufficient to prevent the general poisonous effects of the lead from becoming active; but at length the action of the poison upon the kidney is to cause chronic inflammation in it—*nephrosis*, as it is called—with destruction of the delicate mechanism of the organ and important function. Then, the mode of escape cut off, the poison commences to accumulate in the system, and disease is established.

The disease induced by lead is of two kinds, acute and often transient, slow and entirely disabling, or fatal. The first or transient form consists of symptoms of intestinal spasm, *colic*, as it is commonly called; the second of *paralysis*. I have seen, but this is of rare occurrence, an intermediate disease in which the internal spasm, succeeded by fever and by the extrication of an extreme fœtor with the breath, has ended in a paralysis from which the sick man has recovered without other symptoms. Occasionally the spasm of the intestines terminates in death; but as a rule there is perfect and often rapid recovery from this symptom.

The paralysis from lead is never determinately serious from the first, and is so distinctive that the term "saturnine paralysis" has been applied to it. It is in some respects like that form of paralysis from alcohol which I described last year in this place, and it has been compared with the general paralysis which affects the insane. It differs from these, and from all other paralytic affections in many respects, notably in the following particulars:

(1) It attacks most frequently the muscles of the upper limbs. This is so commonly the case that Tanquerel affirmed he had only seen the lower limbs involved in one case out of one hundred and two. His experience is exceptional. I should place the occurrence of general paralysis after the commencement of paralysis of the arms and hands at one in eleven. Still it is the broad fact that the muscles of the hands and arms are those in which the failure of power appears first, and that the failure in a large majority of instances is confined to these parts.

(2) In this paralysis the extensor muscles, the muscles by which we extend the limbs, are first and most deleteriously affected, hence the origin of the condition known as "drop wrist;" the extensor muscles of the hand lose the power to lift the weight of the hand. Later in the course of the disease the same deficiency extends to the muscles that raise the limb altogether.

The loss of power which is induced is due, in the first instance, to failure of nervous stimulus from those nervous centres which direct and excite the muscles of the upper limbs of the body to motion. There is no doubt that all the muscles of the limbs are paralyzed; but, relatively, the group of extensor muscles are less powerful as they are less massive than the flexors. In the extensors, therefore, the enfeeblement is first discovered, and here it continues longest.

Many investigations have been made to determine the mode in which the lead-poison acts in causing the paralytic state; but in this direction little that is definite has been revealed. In what form of chemical combination with the tissues the metal lead is fixed has not been determined; all that is known is that it is distributed largely throughout the body in the cases now under consideration. It has been found in the liver, the blood, the nervous substance, and in the muscles of those who have died from it, but how it is maintained in those parts is not ascertained. The nearest approach towards an explanation is that as a salt of lead it acts on the albuminous parts of the tissues, coagulating them, and becoming itself combined with the solidified structure. In this way the activity of nervous action would readily be cut off; but why particular parts of the nervous system should seem to be involved in preference to other parts is difficult to answer. I have thought, in studying the subject, that possibly the theory of selection of parts for action, which has been most entertained, is a mere fancy; and that all parts of the muscular system are deprived by the lead of nervous stimulus, those sets of muscles which are least powerful feeling the loss of stimulus most rapidly. After a period of inaction from lead paralysis the muscles waste, they become of fawn color and shrunken. From this state they never recover, and when the heart—which, as you know, is a muscle—is involved, the sinking into death is slowly inevitable.

While the artisan is suffering from the influence of this simple but potent poison, other parts of his body, besides the muscles and nervous centres, undergo organic changes. Along his gums extends a deep, dark-blue line which specially indicates the action of the metal. His visceral organs, the liver, the kidneys, the lungs, show a reduced nutrition and shrinking of their tissues.

ACTION OF PEROXIDE OF HYDROGEN UPON FATTY OILS.

By S. COHNE.

BY the action of HO_2 upon fatty oils they become separated into the two distinct classes known as drying and non-drying oils. Though HO_2 does not exhibit any action upon the latter description, it acts powerfully upon the first kind. When a few drops of a weak solution of HO_2 (if containing only half a volume) are mixed and shaken with a drying oil—such, for instance, as linseed, nut, cotton-seed, poppy, etc.—linolic or palmatine acid are immediately separated from it, which, if put into a basin to settle, the linolic acid subsides to the bottom in the form of a greasy mass, while the palmatine acid sets in fine sheets upon the top of the oil. The remaining fluid oil loses its property of a drying oil, and becomes a non-drying oil.

Castor-oil, after treatment with HO_2, does not then so readiily dissolve in alcohol, and when dissolved in sufficient quantity of alchohol it will be found, if thrown on paper, that it will not dry up: consequently HO_2 is an easy test. If olive-oil is adulterated with cotton-seed oil, this being a cheaper article, it may easily be detected even if the adulteration is less than a quarter per cent, as the oil immediately becomes thick and dull.

The HO_2 appears to act upon the oil somewhat as sulphuric acid does upon alcohol—that is, the HO_2 is not decomposed—and when the solution of HO_2 is allowed to settle, and is afterwards drawn from the oil, it can be used again and again, and will continue to act upon a fresh quantity of oil with a like resu t.

The weak solution of HO_2 may remain for months under oil without being decomposed, even though heated up to 100° F.; similarly, as Saussure has found, a layer of nut oil, if inclosed with oxygen gas, absorbs in eight weeks in the shade only three times its bulk of that gas. As drying oils are usually much cheaper than non-drying oils, advantage may be taken of the foregoing facts to convert the drying into non-drying oils for lubricating purposes.—*Chemical News.*

ANALOGY OF CYANOGEN TO OXYGEN.

By WILLIAM SKEY.

OXYGEN, especially when in the allotropic form, combines directly with metals generally, including gold and silver; moreover, it combines with hydrogen to form a neutral compound, and this, when electrolyzed, delivers its oxygen at the positive pole. Besides this, cyanogen resembles oxygen, wherein, as shown, it differs from the chlorine group, its compound with the alkaline metals being caustic, and those with the heavy metals characterized by great insolubility in water, while several of these cyanides are soluble in alkaline cyanides, precisely as several of the metallic oxides are soluble in alkaline oxides; further, cyanogen, like oxygen, is capable of assuming an allotropic condition.

Following up analogies here, I would class cyanogen and sulphur together, and so I would their hydrides. HS, like cyanogen, is not strongly acid, indeed probably not acid at all; for, as in the case of hydrocyanic acid, HS exhibits a great tendency to oxidize when in contact with water and to form oxyacids, so that in testing this gas for acidity we are liable to obtain reactions not due to the gas itself.

Our new nomenclature, by doubling the equivalents of oxygen and sulphur, has disturbed the uniformity which before this existed between their common hydrides and that of cyanogen; thus one point of resemblance has been removed, but I think this has been done somewhat arbitrarily in regard to cyanogen. Certainly, when the equivalent of cyanogen is retained, its hydride then being CyH (hydrocyanic acid), comparing with that of chlorine, the supposed similarity of these substances is maintained; and this, by the way, may have been one of the reasons for which the doubling process described was broken off at cyanogen. However, if I am correct in assuming that this compound is analogous with oxygen rather than with chlorine, its equivalent will also require doubling. If you now agree with me, or at least will contemplate the possibility, that cyanogen is not analogous to chlorine and its isomorphs, but rather to oxygen, you will be in a position to perceive certain interesting relations which it bears to oxygen, and which could not well have presented themselves had the assumption I have here attempted to disprove remained unassailed.

Thus ferro and ferri-cyanogen become, upon this view, ferri-oxides in which oxygen is replaced by its isomer, cyanogen, and the same being true for the rest of the metallic cyanides, these substances should be, I think, viewed as comparing with the oxides of sulphur and chromium as they exist in the sulphates or chromates; further, sulpho-cyanogen and seleno-cyanogen, the only compounds containing cyanogen (or at least its elements) which do compare with the simple halogens, are not at all analogous with cyanogen. The cyanides thus viewed are not salts at all any more than the oxides are: sulpho-cyanides, on the other hand, are true salts, comparing exactly with the corresponding salts of the halogens.

Further, in regard to the question often raised as to the nature of certain of our elements, whether compound or not, it seems interesting that in this compound (cyanogen) we have a substance very similar to the element oxygen, one which at least only varies from it within the limits we are compelled to allow for *variation* in the members of certain well-defined natural groups of our elements. We are thus, as far as is allowable from such apparent resemblances, justified in entertaining the supposition that oxygen itself is also a compound body. I need not remind you in this connection that any theory which touches upon the nature of this gas has now an especial interest to us, for, as you will be aware, this and our most common gases or gaseous vapors are, for good reasons, considered to be distributed throughout the earths and suns generally, and even to pervade the spaces between them, and to perform all the functions we have hitherto allotted to a purely hypothetical substance. The nature, therefore, of any gas which is possibly a constituent of that which we now consider to be a universal atmosphere becomes invested with an importance to us far beyond what we could even conceive of a short time since

Lastly, in regard to the question as to the nature of our elements, it appears a very noteworthy circumstance that, by combining cyanogen with sulphur, which is also an analogue of oxygen, we obtain a compound analogous to the halogens I have referred to. That this ternary compound, sulpho-cyanogen, should be thus a true salt radical is strongly favorable to the idea that one or more of the chlorine group of elements is of a compound nature, and in relation to this it is worthy of record that, as I have already pointed out, the "equivalent number of sulpho-cyanogen is one which is very nearly the mean between that of chlorine and bromine."

However, whether these facts indicate any thing of this kind or not, I think the object of this paper has been fulfilled, for I believe I have shown that, to use a familiar but significant phrase, cyanogen has not the "stuff" in it for making a salt radical single-handed, therefore it is not in any way analogous to one, but in order to make it so we must combine it with another element, so that three elements in place of two are as yet the smallest number required to form a compound salt radical.

DR. LETHEBY.

AT the comparatively early age of sixty died, on the 30th of March, Dr. Henry Letheby, who for many years had been eminent in his profession, who had justly gained an extensive popularity, and whose advice was eagerly sought after and greatly valued by those who required the assistance of a chemical expert.

As a technological chemist Dr. Letheby was second to none; and in whatever capacity he was acting—whether as lecturer on Chemistry, Toxicology, and Technology; as Gas and Water Examiner; as Medical Officer of Health; or as Analytical and Consulting Chemist—he always gave evidence of having industriously mastered the minutest details of his subject. His complete knowledge of Chemistry and Toxicology, and his intimate acquaintance with the Sciences of Comparative Anatomy and Physiology, rendered his opinion on subjects connected with medical jurisprudence of especial value.

His writings and labors are so varied and numerous that we can not refer to them all. To show, however, that we have not unduly magnified his high qualities, and also that in his death Chemical Science has sustained a great loss, we may refer to his admirable lectures on "Food," delivered before the Society of Arts, and afterwards, at our request, revised and published in book form; to his lectures on "Practical Toxicology;" to his papers on the "Mode of Conducting Post-mortem Examinations in Cases of Suspected Murder;" to his reports "On the Sanitary Condition of the City of London;" on the "Practice of Disinfection and the Right Use of Disinfectants;" on the "Utilization of the Waste Products in the Manufacture of Coal Gas;" on "Noxious and Offensive Trades and Manufactures;" on the "Detection of and Tests for Aniline," etc.—*Chemical News.*

MESMERISM IN DENTISTRY.

A LADY came to my office, after having broken two engagements, to take an anæsthetic, and said, "Have you any objections to extracting teeth for me while under the influence of mesmerism? Prof. W. offers to mesmerize me." I gave my consent. He took a position in front of the patient, and after a few gentle strokes of his hands over her face, motioned to me that all was ready. Six teeth were extracted before she left the chair. She expressed herself as not having felt the least particle of pain.

I do not remember of ever having had so timid and nervous a patient. While making the preliminary examination she would not allow me to use an excavator.—J. C. HENRY, New-Albany, Indiana.—*Dental Cosmos.*

PRODUCTION OF METHYLANILINE VIOLET DIRECTLY ON COTTON.

By ALBERT DUPUY.

PRINTING goods with a solution of methylaniline chlorate (containing 3 to 4 per cent of methylaniline) which should be neutral, or, if any thing, should contain an excess of base and ageing at a temperature of 30° to 35°, is the method proposed. The addition of $\frac{1}{2}$ to $\frac{1}{4}$ per cent of red prussiate hastens the development of the color, and renders it more uniform. The chlorate prepared with methylaniline, potassic chlorate, and tartaric acid, is not so good for the purpose as that prepared with pure chloric acid. Boiling water will extract the color from the goods, leaving a gray.

Fig. 1.

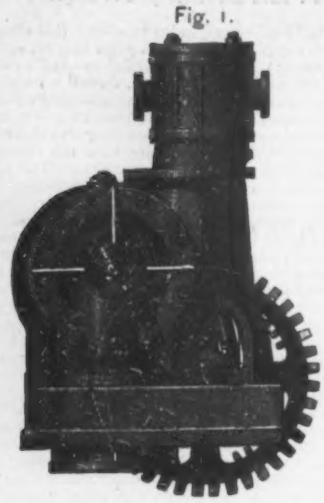
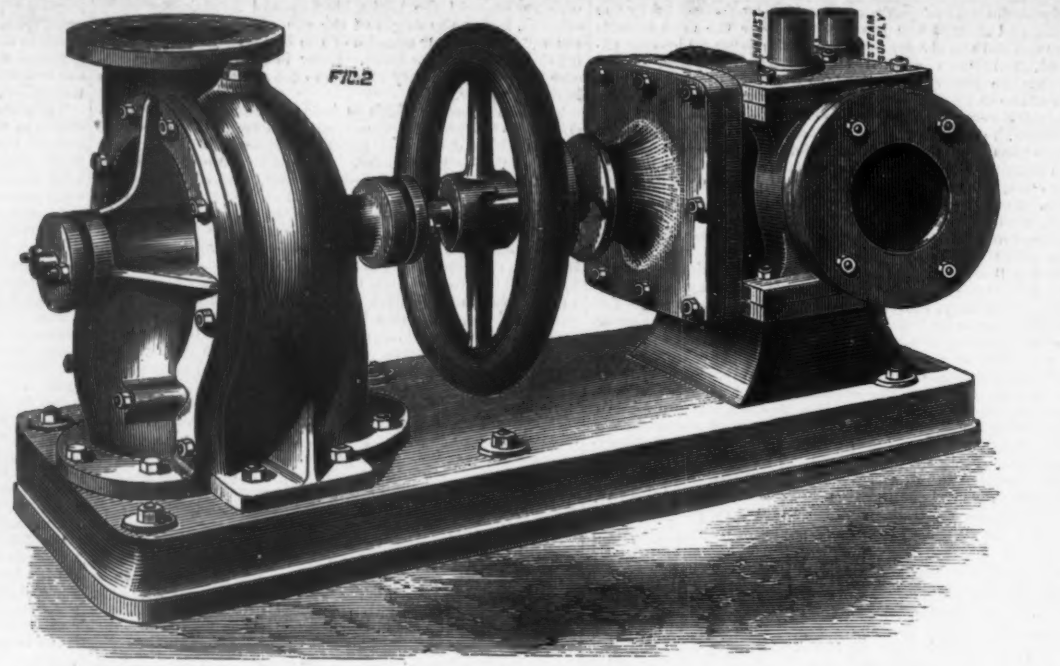


FIG. 2



COMBINED CENTRIFUGAL PUMP AND ENGINE.

CENTRIFUGAL PUMP AND ENGINE.

THIS is the invention of Lawrence and Porter, Parliament street, London, and the principal peculiarity about it is the arrangement for obtaining access to the interior, which is effected by removing one side, as shown. When the pump is to be used combined with an engine of considerable power, the arrangement shown in Fig. 1 is used.

The second arrangement has been specially devised for the use of contractors and others who require extreme simplicity, lightness, and small first cost, without regard to special economy of fuel. The pump is in this case driven by a very simple engine, devised by Mr. George Fletcher. The engine consists of two single-acting cylinders, the pistons facing each other. There are no piston-rods, and the connecting-rods lay hold of a single crank. The slide-valve is worked by a pin in the end of the crank-shaft, taking into a slot in the valve. This engine runs almost without noise at a tremendous pace, 800 revolutions per minute, being a much lower speed than that at which we have seen it work, the revolutions being registered by an endless screw and worm-wheel gear.

In the course of some experiments which we recently saw carried out with the pump and engine combined as shown, water was pumped into a tank, the capacity of which was accurately known, at the rate of 840 gallons per hour, the clear height of the lift being 10 ft. This is at the rate of 3.75 tons per minute, or 225 tons per hour—a very excellent result from a 6-in. pump. The entire weight of pump, engine, and all is only 9 cwt.—a point of considerable importance as regards carriage and export. A considerable number of these pumps has been sent abroad, and when fitted with a belt pulley and driven by a small portable engine of the kind made by Ruston and Proctor, of Lincoln, with a 5½-in. cylinder—2½-horse power nominal—they will lift about three tons of water per minute to a height of 10 ft. to 11 ft. They are of course available for higher lifts; but we speak here of actual performances. The pump is sometimes mounted on a pair of light carrying-wheels, provided with shafts for a horse or mule. These shafts are used, when the pump is at work, to connect it to the fore carriage of a portable engine.—*The Engineer.*

IMPROVED HYDRAULIC SHEARS.

THE French Government are now putting down very heavy hydraulic plant, designed by Mr. R. H. Tweddell and constructed by the Hydraulic Engineering Company, Chester, England. We illustrate one of the largest hydraulic shearing-machines ever constructed. It is capable of shearing 1½-in. plates on a 5-ft. gap. The mode of imparting motion to the top knife is very similar to that used in the well-known hydraulic riveting-machinery, a cylindrical ram being used, with a special arrangement inside of it for drawing it back; this drawback is automatic, and for punching machines especially this is a very valuable property, since the moment the man releases the valve-handle the punch leaves the plate, and thus unfair holes are almost avoided. The valve-handle occupies a similar place to the usual stop-motion gear, and, although it requires to be moved for every hole, the speed is as quick as any geared machine. The length of plate sheared by these machines per stroke is very much greater than in those of the ordinary kind, and thus only one fourth of the number of strokes is required to shear the same length of plate, and the wear and tear of parts are proportionately reduced. The knives can be moved into four different positions by simply turning the blocks on their centres. This is a great advantage, as it enables the machine to be equally useful for bars or plates. The mode of attachment of the knife-blocks to the machine is also very neat and mechanical, since every thing is worked from one common centre-line, and no driving-keys, etc., to fix up the knives are required; the power is supplied through wrought-iron tubing, about 1-in. bore.—*The Engineer.*

IMPROVED HYDRAULIC SHEARS.

MR. DUNLAP, a London teacher of swimming, furnishes his pupils with round paddles for the hands, resembling plates in size and shape, and thus enables them to move with great rapidity through the water.

BAR-IRON PIT-GUIDES.

M. DAVY, mining engineer, has lately addressed a communication to the *Société Minérale de Saint Etienne* with respect to the replacing of wire-rope guides at the Layon-et-Loire colliery. In the first instance ropes composed of very fine wire were adopted, but they were soon worn out, when they were replaced with advantage by ropes composed of thicker wire (No. 20). In 1868 the first guides of round-iron rod were put down, and worked well, no sign of wear being perceptible towards the latter end of 1870, after twenty month's service. From the upper portion of the pit-head of the St. Barbara pit to the moorings at the bottom is a depth of 230.15 metres—126 fathoms—in which the tubs laden with coal or water make from 120 to 180 ascents in the twenty-four hours. Each guide-rod is 18 metres—59 ft.—long, and consists of a bar of round iron of average quality, 25 millimetres—about 1 in.—thick. To each end is welded a piece of best iron for forming the joint; one end is conical and fits accurately into a corresponding recess in the next rod; a flat key of the best iron that can be obtained passes through both, and is firmly riveted. The time occupied in laying a length of guide-rod, after the water has been raised and the mooring-sleeper laid in place, is sixteen hours. The experiment was considered so satisfactory that at the Malécots pit two of the guides were replaced with rods in 20-metre lengths, while the other two were renewed with wire rope, at a cost of 671f. for the former and 1197f. for the latter, thus showing a saving in first cost of 526f. in favor of the rod-guides. In the event of the rod guides being twisted through over-winding, they were easily straightened without damage to the joints; but it was ultimately found necessary to abandon their use in the Malécots pit, owing to its bad condition. The rods present considerable advantage over the wire ropes, both as regards first cost and also maintenance, and the difference in value between an old wire rope and a worn-out rod is very great. M. Davy would not hesitate to adopt rod-guides in a pit of not more than 200 metres—109 fathoms—and the bottom of which was constantly accessible. He thinks that the length of the different joints might be increased, and also that they might be welded together in the pit. The rods are, however, more susceptible to changes of temperature, and therefore require more frequent inspection. They are more rigid than the wire ropes, and are capable of conveying signals, made by merely knocking lightly upon them.—*The Engineer.*

UNDER the new time-table, the run by rail between New-Orleans and New-York is reduced to sixty-two hours.

ANTIMONY PHOTOGRAPHS.

MR. FRANCIS JONES is the author of the process. Several specimens of ferns produced, by superposition, by the new process were exhibited at the last meeting of the Photographic Society of Great Britain. These were of an orange tint, and not likely to prove of value from an artistic point of view; but it was shown by illustrative specimens that subsequent treatment with ammonio-nitrate of silver or ammonio-sulphate of copper insured more agreeable tones.

The process is based upon the reaction which takes place between sulphur and antimoniated hydrogen, or stibine, in the presence of light, by which sulphide of antimony results as the product of the decomposition. A sheet of paper is impregnated with sulphur by means of a solution of this elementary body in bisulphide of carbon. And here we may observe that, at the meeting, a method was suggested by Mr. J. A. Spencer which appears to be capable of yielding a deposit of sulphur in a much finer state of division than that adopted in the specimen pictures shown at the meeting by Mr. Spiller. Mr. Spencer's proposal is that after immersing the paper in a saturated solution of hyposulphite of soda, the paper thus treated should be subjected to the action of acid, by which, as every photographer well knows, the hyposulphite will be decomposed and sulphur liberated in the form of an extremely fine powder. On paper charged with sulphur, no matter by what means effected, the future picture is to be produced. But the sulphur is not affected by light until each atom becomes surrounded with an atmosphere of stibine, or antimoniated hydrogen. Means must, therefore, have been effected by causing the pads of the printing-frame—or, at any rate, the sulphur paper already spoken of—to be impregnated with this very poisonous compound of hydrogen and antimony, which is known respectively by the designations "antimonetted hydrogen," "antimoniuretted hydrogen," "hydrate of antimony," and "stibamine," in addition to the terms we have employed.

This gas may be produced in more than one way, but it is probable that the easiest method of obtaining it is by dissolving an alloy of antimony with an excess of zinc in dilute sulphuric acid, when it is freely evolved. It must be conducted from the generator to the printing frame by means of an india-rubber tube which passes through the back of the frame, so as to allow the gas to impregnate the felt pads behind the sulphur paper. The substance resulting from the action of the gas upon the sulphur is sulphide of antimony, well known as an orange-colored body. But as the reaction takes place only in the light, it will be at once apparent that such portions of the paper as are protected from luminous action by the superposition of a fern, a negative, or other light-obstructing medium, will not undergo the same change, and hence the production of a photograph. The gas does not, as one speaker at the meeting observed, act as a developer, but as a sensitizer; for without the presence of this gas, and without the further presence of light, the sulphur upon the paper is quite inert.

The sensitiveness of the paper is not very great; for, if we rightly understood Mr. Spiller, an exposure of from ten to twenty minutes in the sun is required in order to produce the desired effect.

It is, perhaps, a little premature to offer any opinion upon the future of the process; but we have a strong impression that the proposed process will be relegated to the limbo of what are termed "interesting" processes, of whose existence photographers are sufficiently content to be made cognizant without once entertaining the idea of subjecting them to the test of experiment. We incline to this opinion because of the troublesome nature of the process of printing indicated, the noxious character of the gas which forms such an important agent in it, and the very unsatisfactory quality of the tones obtained. It is true that, by subsequent treatment with certain silver or copper salts, the tone may be improved; but we believe that photographers will prefer silver-printing pure and simple to a process such as that we have here described, which involves disadvantages not compensated for by qualities that can be recognized as of a progressive character.—*British Journal of Photography.*